

DOCUMENT RESUME

ED 344 767

SE 052 732

TITLE Science: Grade 8. Interim Guide.
INSTITUTION Manitoba Dept. of Education and Training,
Winnipeg.
REPORT NO ISBN-0-7711-1013-8
PUB DATE 91
NOTE 165p.; For other individual guides, Kindergarten
through Grade 9, see SE 052 724-733.
PUB TYPE Guides - Non-Classroom Use (055) -- Tests/Evaluation
Instruments (160)

EDRS PRICE MF01/PC07 Plus Postage.
DESCRIPTORS Aviation Education; Classroom Environment; Curriculum
Guides; Energy; Foreign Countries; *Grade 8; Heat;
Junior High Schools; Plants (Botany); *Process
Education; Science Activities; Science Fairs; Science
Instruction; *Scientific Concepts; *Secondary School
Science; Student Attitudes
IDENTIFIERS Cells (Biology); Concept Maps; Discrepant Events
(Science); Manitoba; *Scope and Sequence

ABSTRACT

This guide is one of a set of 10 science guides, each covering a separate grade in Manitoba, together covering kindergarten through grade 9. The guides have been designed to provide a framework for building scientific concepts and developing the learning of process skills. They replace an earlier set of guides dated 1979. Each guide is essentially the same through the first 16 pages, after which the core units vary appropriately for each academic level. Three themes and units within those themes which are carried through the K-4 program include: (1) environmental interdependency and interaction-- cells and organ systems/plants and the environment (grade 8); (2) matter and energy--heat/alternative energy forms/flight (grade 8); and (3) earth, time and space--(grade 8). development: K-9; (3) science processes development: problem solving, K-9; (4) objectives and concepts for STS interactions; (5) K-9 STS content; (6) uses of computers in science; (7) safety in science; (8) women in science; (9) science fairs; (10) basic equipment lists for grades 5-9; (11) directions for using the microscope; and (12) a copy of the response questionnaire for the K-9 program of studies. (KR)

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science: grade 8

interim guide

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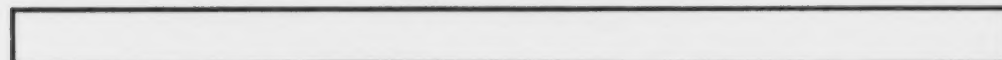
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science: grade 8



interim guide

THIS GUIDE IS SUBJECT TO REVISION ON THE BASIS OF INFORMATION RECEIVED FROM SCHOOLS. IT IS EXPECTED THAT MODIFICATIONS WILL NOT BE MADE IN THE DESIGN OF THE PROGRAM. RATHER, CHANGES MAY BE MADE IN AREAS CONCERNING STRATEGIES AND IMPLEMENTATION.

manitoba education and training

1991

ISBN 0-7711-1013-8

This guide was prepared by Manitoba Education and Training to provide students with some basic understandings and skills in science. The interim form of this guide has been developed on the basis of feedback from teachers during the period of 1988-89. The 5-9 science program has been designed to articulate with K-4 science and to provide basic concepts and skills which will be useful to students continuing in the sciences. This guide may be used in September, 1991, in place of the previous (1979) guide.

ACKNOWLEDGEMENTS

Manitoba Education and Training acknowledges the contributions of the following members who constituted the committee responsible for the development of this guide:

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INTRODUCTION

RATIONALE

The previous science curricula, designed during the period of 1976-78, were concerned with helping students to rationally process data within the context of a scientific knowledge which could sometimes be applied to student and environmental concerns. These emphases occurred because of the apparent needs of the middle years student, the impact of environmental and energy problems upon the aims of science education, and the potential effect of science and technology upon the student and society. Although the specifics may have changed since the 70's, the general needs of the 11-15 year old students and aims of science education which can satisfy these needs remain unchanged. However, the need to review an area of science education with a high impact upon students' future decisions, the increased effect of science and technology upon the individual affecting our need to understand this area, teacher feedback concerning the program, and other items have indicated a need to modify some of the emphases and design of the program.

During the last two years, teacher surveys relative to the K-6 and 7-9 science programs have been conducted. These surveys and a major Science Council report¹ indicated that a general or integrated science program should be retained which had a balance among major ideas that would aid students in applying them to his/her environment; and to provide a flexibility in the design of the program. In addition, the surveys indicated a need to review some of the space, environmental, and physical science units. Because the K-9

science program was reviewed, it was possible to examine the sequence and development of concepts and processes in such areas as the environmental theme. Thus, some units such as the Grade 7 unit on micro-organisms was modified to reflect a greater environmental emphasis.

Newspaper articles and television reports are constantly reminding us of the increasing impact that science-technology has upon humans and their environment. An introduction to the nature, strengths and limitations of science and technology occurs in this curriculum and is applied more fully in the senior years. For example, the science and technology of flight and possibilities of energy conservation are introduced and applied.

Students are bombarded with a tremendous amount of data which is sometimes conflicting and of uncertain validity. Consequently, they need skills to organize and evaluate information, and to apply scientific knowledge to life situations. In order to help students to become scientifically literate in today's society, this curriculum should begin to develop the following attributes:

- . Understands scientific concepts and their applications in practical situations.
- . Recognizes the strengths and limitations of science and technology and their applications to life management and societal decisions.
- . Applies science processes, concepts, and values to problem-solving and responsible decisions.

¹ Science for Every Student. Science Council of Canada.

- . Understands and respects the ethics of science and the relationship of science to other fields of learning.
- . Maintains a positive interaction with their environment.
- . Develops an interest in science-related skills which can be applied to lifelong learning.

AIMS (GOALS)

GOALS OF THE SCIENCE 5-9 CURRICULUM

In general, today's educational goals emphasize the need to help learners to achieve their potential as responsible individuals. These individuals will have acquired the knowledge and skills for understanding ideas and solving problems; developed respect for others, their cultures, and the environment; and remained an active learner with a productive future. The goals of science education contribute to general learning goals through experiences which help students to understand the nature of science and technology and the ability to apply their knowledge and skills to managing their lives. As a student progresses from Science 5 to Science 9, the following skills, knowledge and attitudes should be acquired:

- 1) An understanding and facility in applying the skills and processes of science.

Processes of science include identifying a problem, observing, inferring, formulating models and experimenting. The complete list of processes can be found on page 24. In addition, an understanding of the nature and limitations of science will be developed.

The psychomotor skills necessary for proper laboratory techniques and safe handling of equipment and materials are included.

- 2) A facility in problem solving using science.

Students will be provided with opportunities to use scientific concepts and processes to define problems and reach conclusions. Some of the skills, which will be developed, include the ability to:

- . Recognize and define a problem, its central issues and assumptions.
- . Develop alternate solutions to a given problem.
- . Evaluate evidence including gathered data, print and non-print information, and the validity of conclusions.

- 3) The basic knowledge and attitudes* needed to function in a scientific and technological world.

Concepts are provided in the areas of life-environment, earth-space, and physical sciences. Attitudes, to be developed, include a curiosity and interest in scientific phenomena, questioning of all things, respect for accuracy and precision, belief in cause-effect relationships, and suspension of judgment pending adequate data.

- 4) An understanding and appreciation of the relationship between science and technology and their relationship to society and the individual.

Students will have opportunities to develop understandings such as:

* See Attitude and Values, page 3.

- . The nature of science as a search for truth, with presently tentative understandings based upon both rational insight and chance discovery.
- . The differences between science and technology and their abilities and limitations for solving problems.
- . The recognition of potential implications for society of scientific discoveries.

The student is affected personally by the growth of scientific knowledge. The student should become aware of how the knowledge of science enhances personal life management. For example an understanding of such things as properties of matter and radiation, plants and animals, the environment and natural resources, chemical reactions, and appliances and machines will help students enrich and manage their own lives at school and in the future.

- 5) Respect for the environment and the relationship of science to issues and values.

Students will be provided with opportunities to develop a respect for living things, the nature of their interactions, and the potential effects of human decisions upon the environment. During the upper levels of the curriculum opportunities to use science information and skills to examine and clarify various social and environmental issues will be provided.

- 6) Awareness of the career opportunities in science and technology.

ATTITUDES AND VALUES

The student should develop positive science attitudes which can be either scientific or environmental in nature.

SCIENTIFIC ATTITUDES

1. Develop a curiosity about natural events that occur on Earth.
2. Become aware of the universe and its contents.
3. Recognize the impact of space research and space technology on communication, weather prediction, and spin-offs.
4. Value the differences that exist between organisms, including humans.
5. Foster an appreciation of technology on society.
6. Develop an awareness of how scientific research and development affect our lives.
7. Develop a concern for energy and the need to conserve energy.
8. Be aware of alternative forms of available energy.
9. Appreciate the impact of chemicals.
10. Develop a concern for safety in the home and school.

11. Deal with problems in an open-minded manner.
12. Use scientific knowledge and skills to clarify personal values.

ENVIRONMENTAL ATTITUDES

1. Appreciate the environment and the interactions of life forms within the environment.
2. Develop an awareness of threats to the environment such as greenhouse effect, acid rain and pollution.
3. Distinguish between the proper use and the misuse of chemicals on the environment.
4. Develop a responsible attitude towards managing and conserving the environment.

LEARNING THEORY AND PROGRAM DESIGN

The Science 5-9 program attempts to consider present knowledge of the intellectual and social development of middle years students and the nature of science education in designing the program. As illustrated in the aims, science education is concerned with helping students to apply concepts to their interpretation and management of their world. In the past, much has been written about intellectual development from the stage of focusing on the particular and concrete to the formal operational stage². Although science education research has maintained its interest in developmental ideas, recent research has also been concerned with the efforts of students' preconceptions about the real world upon their understanding of the world as defined

scientifically. A current perspective of learning maintains the view that learning is an active process with the following concepts³.

- . Students' conceptions, purposes and motivations influence the way in which they interact with learning materials in various ways. Those commonly held concepts of systems which are different from the scientific reality are called misconceptions.⁴ For example, a common misconception about current electricity is that current is used up as it flows around a circuit.
- . Learning involves constructing meaning as a continuous and active process. Although the meanings may appear to be incoherent to others, the student may not see the idea as incoherent. For example many young children believe that an object sinks more readily in deeper water.
- . Meanings are stable; modification of a meaning is dependent upon a student's belief. Although students may be able to develop a new idea which conflicts with old, they are often reluctant to accept it and develop a new system of thinking. For example, some students in physics tend to associate constant force with constant motion and have difficulty in accepting that tables and walls, in static equilibrium, can exert forces.

³ Driver, R. and Bell, B. "Students' Thinking and the Learning of Science: A Constructivist View", School Science Review, March, 1986, p. 443, 456.

⁴ Eaton, J. F., Anderson, C. W., Smith, E. L. "What Students Don't Know. They Don't Know", Science and Children, April, 1983, p. 7-9.

² Osborne K. Middle Year Sourcebook: Some Suggestions for the Education of Early Adolescents. Department of Education, Province of Manitoba, 1984.

- . Some meanings are shared i.e. commonly held ideas can be identified. For example, research indicates that children have a tendency to identify heat with temperature and to consider heat as having fluid properties. Heat transfer is better understood when a temperature change occurs (conduction) than when it does not (change of state)⁵. In regard to plant nutrition, many students associate food getting with the soil and have little understanding of the relationship between photosynthesis and other physical and chemical processes⁶. After all don't we say "Give that carnation some plant food?"⁶

The above learning assumptions and research findings have a number of implications for the design and teaching of science.

IMPLICATIONS OF LEARNING THEORY TO THE DESIGN AND TEACHING OF THE SCIENCE PROGRAM

Learning theory has been related to the design of the Science 5-9 program and teaching strategies in the following ways:

- . The program design has attempted to provide a developmental sequence of tasks and skills whereby students are required to process data and vari-

⁵ Brook, A. et al. Aspects of Secondary Students' Understanding of Heat Centre for Studies in Science and Mathematics Education, The University of Leeds, 1984.

⁶ Bell, B. et al. Plant Nutrition. Centre for Studies in Science and Mathematics, University of Leeds, 1985.

ables. An increase in the complexity of the variables which are considered and the degree of student input or control is increased e.g. the testing of a consumer product or of a hypothesis.

- . Variation among students is considered within the program design in two ways. Firstly, the program provides suggestions for a wide range of activities. Secondly, the design has been modified in order to provide additional time. The time is critical for encouraging students to hypothesize and generate models, test assumptions, and to explore concepts with others.
- . A need exists to apply concepts in a variety of real-world or practical situations. For example, many students believe that steel and wood in a room are at different temperatures. Students should examine heat transfer and temperature with a variety of materials. The science-technology-societal theme encourages application in topics such as flight or the design of models.
- . Language development correlates highly with the development of reasoning skills according to a number of research studies. Teachers should consider the following activities to support the development.
 - a) Incorporate reporting tasks where connective terms such as "since, hence, similarly" are required to summarize results.
 - b) Use examples that require formal reasoning with concrete situations.
 - c) Provide practice in visualizing and verbalizing concepts and ideas.

- . Since students are developing more sophisticated understandings over time, the curriculum design has included aspects of a spiral curriculum within some of the themes.
- . Pupil interaction with concrete situations requires that teachers spend the necessary class time getting students to make sense of their experiences and by helping them connect activities to past and future science knowledge. This can be supported by determining students' ideas (including misconceptions) early in a unit creating situations whereby they must clarify their ideas, evaluate alternatives, and apply them in a range of situations. This can be achieved by focusing on the processes rather than on the content of science.

SELECTION AND USE OF CURRICULUM MATERIALS

In this revised course, the curriculum consists of the objectives of each unit as listed in the expanded outline. The materials presently in the schools as well as the materials which will be recommended on an on-going basis by the Department of Education and Training are to be used by students and teachers to develop the concepts or skills specified in the objectives. Teachers are encouraged to seek out additional materials which will provide them with assistance in planning their lessons.

GENERAL PROGRAM OVERVIEW AND ESTIMATED TIME ALLOTMENTS

THEMES	5	6	7	8	9
ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION	Adaptations to Environment	Interactions of Populations with Environment	Microbes and Ecosystems (22)	Cells and Organ Systems (24) ----- Plants and the Environment	Reproduction and Heredity (18) ----- Plant and Animal Interactions (24)
CHANGES IN MATTER AND ENERGY	Electric Charges ----- Force and Motion ----- Physical and Chemical Changes	Force and Motion ----- Machines -----	Light (22) ----- Physical Properties (16) ----- Physical Changes of Matter	Heat (22) ----- Alternative Energy Forms (16) ----- Flight (22)	Force, Work and Motion (18) ----- Chemical Interactions (18)
EARTH, SPACE AND TIME	Changing Earth	Weather ----- Earth in Space	Rocks, Minerals and Soils (24) ----- The Observable Universe (16)		The Changing Earth's Crust (22)

NOTE: Grades 5 and 6: Recommended 30 minutes per day for science. Units are of approximate equal length.
Grades 7, 8 and 9: Estimated time (hours) per unit.

SCOPE AND SEQUENCE

THEME	GRADE K	GRADE 1	GRADE 2	GRADE 3	GRADE 4
INTER-DEPENDENCY AND INTERACTION	<u>LIVING AND NON-LIVING</u> . characteristics . plants as living organisms, growth needs	<u>ANIMALS</u> . animal characteristics . comparison of different animal properties . animal care <u>OURSELVES</u> . variations and comparisons among people . characteristics	<u>ORGANISMS IN THE ENVIRONMENT</u> . properties unique to six animal groups (insect, birds, mammals...) . properties of deciduous trees and plant needs . organisms - response to stimuli . animal-plant characteristics and habitats . man's interactions	<u>LIFE CYCLES</u> . complete and incomplete metamorphosis . animal behaviour and instinct	<u>POPULATION INTERACTIONS</u> . nature of a population and habitat . animal interdependency herbivores, carnivores, omnivores, and predator-prey . food recycling, food chain and web . population - environment interactions . human interactions

SCOPE AND SEQUENCE

THEMES	GRADE 5	GRADE 6	GRADE 7	GRADE 8	GRADE 9
INTER- DEPENDENCY AND INTERACTION	<u>ADAPTATIONS TO THE ENVIRONMENT</u> - structural and behavioural adaptations (plants and animals) - Adaptations related to distribution, reproduction and survival	<u>INTERACTIONS OF POPULATIONS WITHIN THE ENVIRONMENT</u> - populations needs and competition - Producers and consumers - Human dependency and interaction with environment	<u>ENVIRONMENT</u> - ecosystems-interaction of biotic and abiotic factors - yeast is a decomposer - Factors affecting population growth in a yeast culture - microorganisms - benefits and harm	<u>ENVIRONMENT</u> - factors involved in photosynthetic process - growth and soil - plant respiration - plant role in environment and with man <u>CELLS AND ORGAN SYSTEMS</u> - organization - cell to system - structure and function - circulatory and respiratory systems - Health problems and solutions	<u>INTERACTIONS</u> - interactions-competiton to commensalism - energy changes in food chains to pyramids - Nature of succession - Management <u>REPRODUCTION AND HEREDITY</u> - asexual and sexual cellular reproduction - human reproductive system, structure and cycles - variations in human traits - genetic control and prediction

SCOPE AND SEQUENCE

THEME	GRADE K	GRADE 1	GRADE 2	GRADE 3	GRADE 4
MATTER AND ENERGY	<u>PROPERTIES OF OBJECTS</u> - senses help determine properties of objects (size, colour, shape, texture, hardness, weight) - classification and identification from properties - change in properties	<u>PROPERTIES OF MATTER</u> - materials have unique properties, can identify - characteristics of solids and liquids - changes in solids' properties (dissolved, heated) - patterns and order in change	<u>FLOATING AND SINKING</u> - objects vary in ways they float - different liquids and shape affect an object's floatation - depth of a liquid has no effect - designs of objects can be tested for floatation	<u>CHANGES IN MATTER</u> - matter made of parts - particles in liquids and gases - separation in mixtures - liquids vary in properties - nature of physical change <u>AIR AND AIR PRESSURE</u> - properties of air - warm air rises - air contains water vapour <u>HEAT AND TEMPERATURE</u> - heat energy causes motion - expansion and contraction - temperature measurement - conductors and insulators - absorption - colour	<u>SOUND</u> - sound caused by vibrations, pitch - sound travel - direction, loudness - sound conductivity - sound pollution and control <u>STRUCTURES</u> - cell structure and characteristics - skin and skeletal structures - materials, size and strength - size, shape design and materials affect a structure's strength <u>ELECTRICITY</u> - single cell circuit and switch - several cells circuit (one bulb) - series and parallel circuit - conductors, insulators and the light bulb

SCOPE AND SEQUENCE

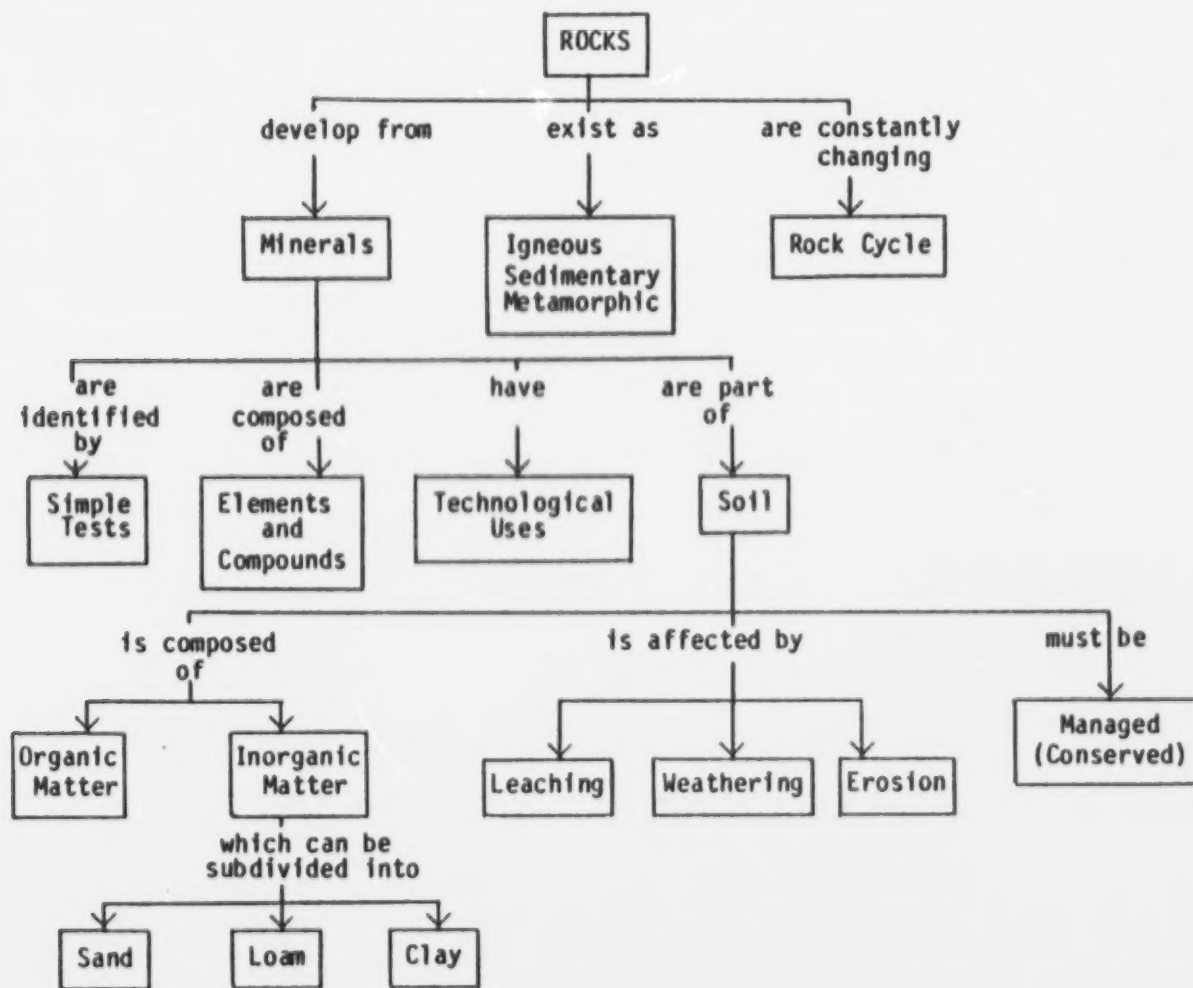
THEME	GRADE 5	GRADE 6	GRADE 7	GRADE 8	GRADE 9
MATTER AND ENERGY	<u>CHEMICAL AND PHYSICAL CHANGE</u> - properties identify objects - characteristics of physical change (shape, size, state mixtures) - chemical change characteristics	<u>FORCES AND MOTION</u> - force on an area - factors affecting floatation and design of floating objects	<u>PHYSICAL PROPERTIES</u> - changes in state, water cycle - fusion, vapourization and temperature - factors affecting solutions and separation - properties of industrial products, testing	<u>HEAT</u> - heat and temperature - energy transformations to heat - heat transfer and applications - expansion, contraction and applications - alternative sources	<u>CHEMICAL COMPOSITION AND CHANGE</u> - characteristics of chemical change - elements, atoms, compounds and reactions - conservation of matter - acids and bases, characteristics and tests - household chemistry and safety
	<u>ELECTRIC CHARGES</u> - static electricity - nature and production - electric current - chemical production, electro magnetism, applications	<u>FORCE AND MACHINES</u> - effort and resistance relationships (six simple machines) - lever, inclined plane and pulleys relationships are quantitative - complex machines contain two or more simple machines	<u>LIGHT</u> - transformation of light energy - light transmission - reflection and refraction - light and colour - uses of lens	<u>ALTERNATIVE FORMS OF ENERGY</u> - formation or production of fossil, solar, nuclear, wind, and hydro-electric energy - cost-benefits of alternatives	<u>FORCE-WORK MOTION</u> - unbalanced forces, gravity - quantitative relationships within simple machines - mechanical advantage, work and efficiency - friction effect on efficiency
	<u>FORCE AND MOTION</u> - unbalanced forces on motion - weighing objects - balance beam and spring scale - transmission of forces and test of strength			<u>FLIGHT</u> - factors affecting - lighter-than-air flight - forces and controls on heavier-than-air flight - design factors - flight in space	

SCOPE AND SEQUENCE

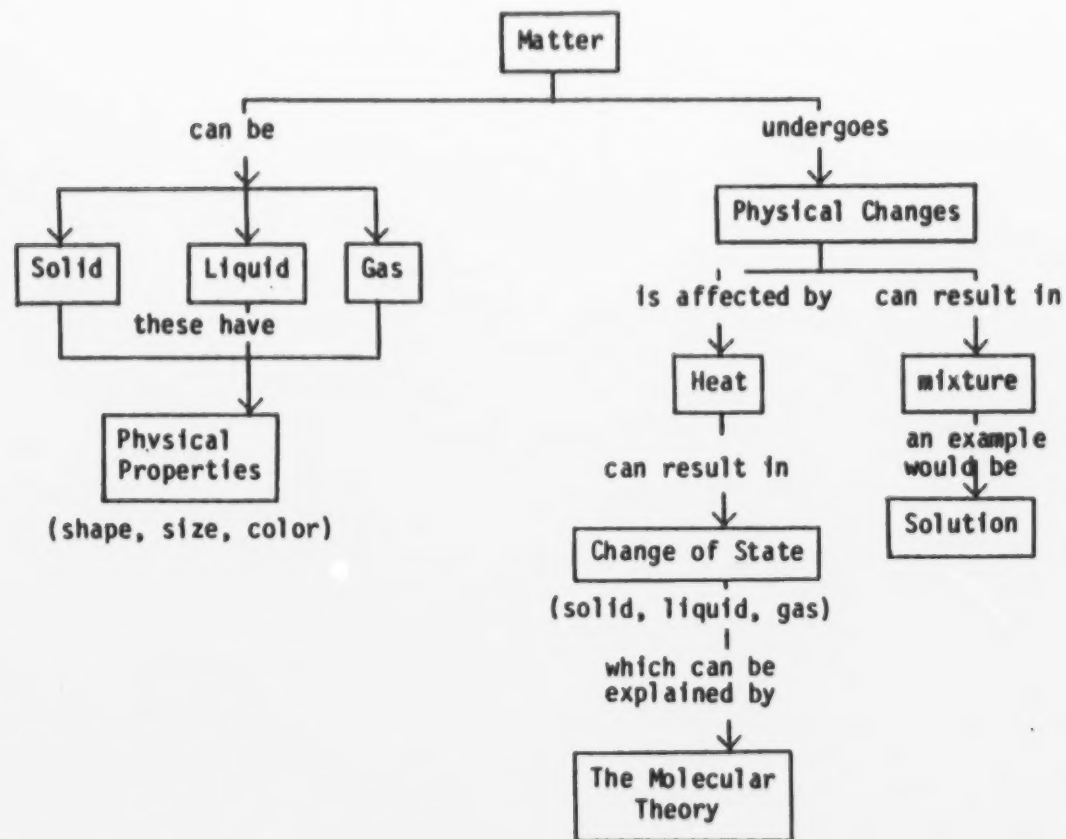
THEME	GRADE K	GRADE 1	GRADE 2	GRADE 3	GRADE 4
EARTH, TIME AND SPACE	<u>SIZE, POSITION AND TIME</u> - size comparisons (non-standard units) - reference points and position - ordering of events	<u>COMPARING AND MEASURING EVENTS</u> - regular and irregular events - events in time sequence - time measurement (non-standard and standard units)	<u>MEASURING TIME AND POSITION</u> - time measurement - standard units - size and distance - standard units - position location measurement <u>LIGHT AND SHADOWS</u> - light position and size, nature of shadows	<u>SUN, EARTH AND MOON</u> - light reflection and conduction - sun - object shadows - relative position - night and day, moon phases <u>THE OBSERVABLE UNIVERSE</u> - location using a coordinate system - moon characteristics and earth-moon interactions - characteristics of sun as a star - constellations, galaxies - technology of space	<u>WATER AND LAND</u> - erosive effects of water - factors effecting erosion - absorption of water into land - water cycle - conservation

SCOPE AND SEQUENCE

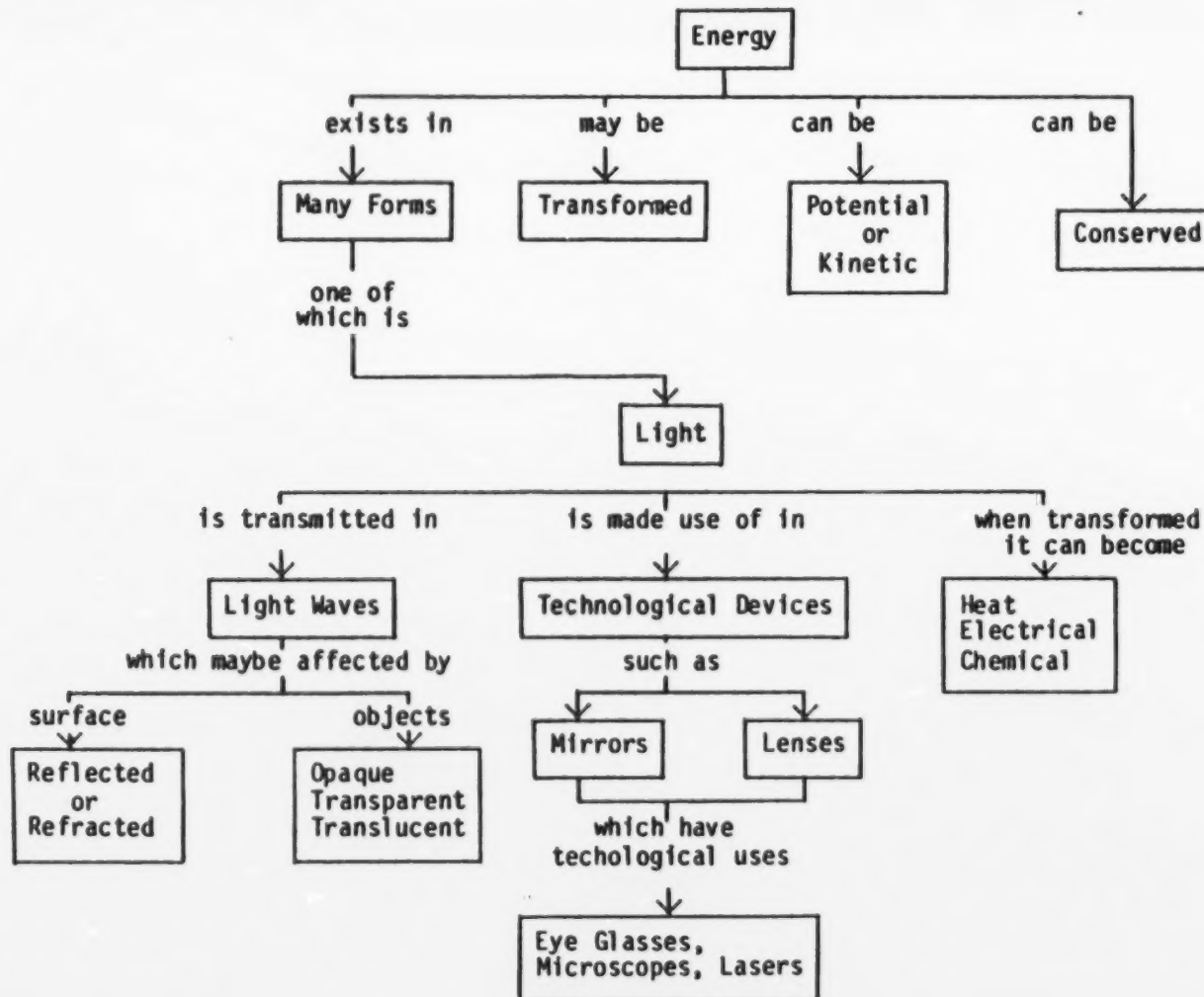
THEME	GRADE 5	GRADE 6	GRADE 7	GRADE 8	GRADE 9
EARTH, TIME AND SPACE	<u>CHANGING EARTH</u> . rocks and minerals . sedimentary rock formation . fossil formation	<u>EARTH IN SPACE</u> . rotation and time . revolution and seasons . planets in the solar system . technology for observation <u>WEATHER</u> . factors affecting air movement . humidity, air movement relates to cloud formation and precipitation . weather and air masses, prediction and technology	<u>ROCKS, MINERALS AND SOILS</u> . igneous, sedimentary and metamorphic rocks . the rock cycle . testing of minerals . uses of rocks and minerals . nature and production of soil . erosion and soil management <u>THE OBSERVABLE UNIVERSE</u> . location using a coordinate system . moon characteristics, and earth-moon interactions . characteristics of sun as a star . constellations, galaxies . technology of space		<u>THE CHANGING EARTH'S CRUST</u> . Alternate theories for continental structure . evidence for plate tectonics theory . technological support . relationship of plates to volcanoes, earthquakes and mountains



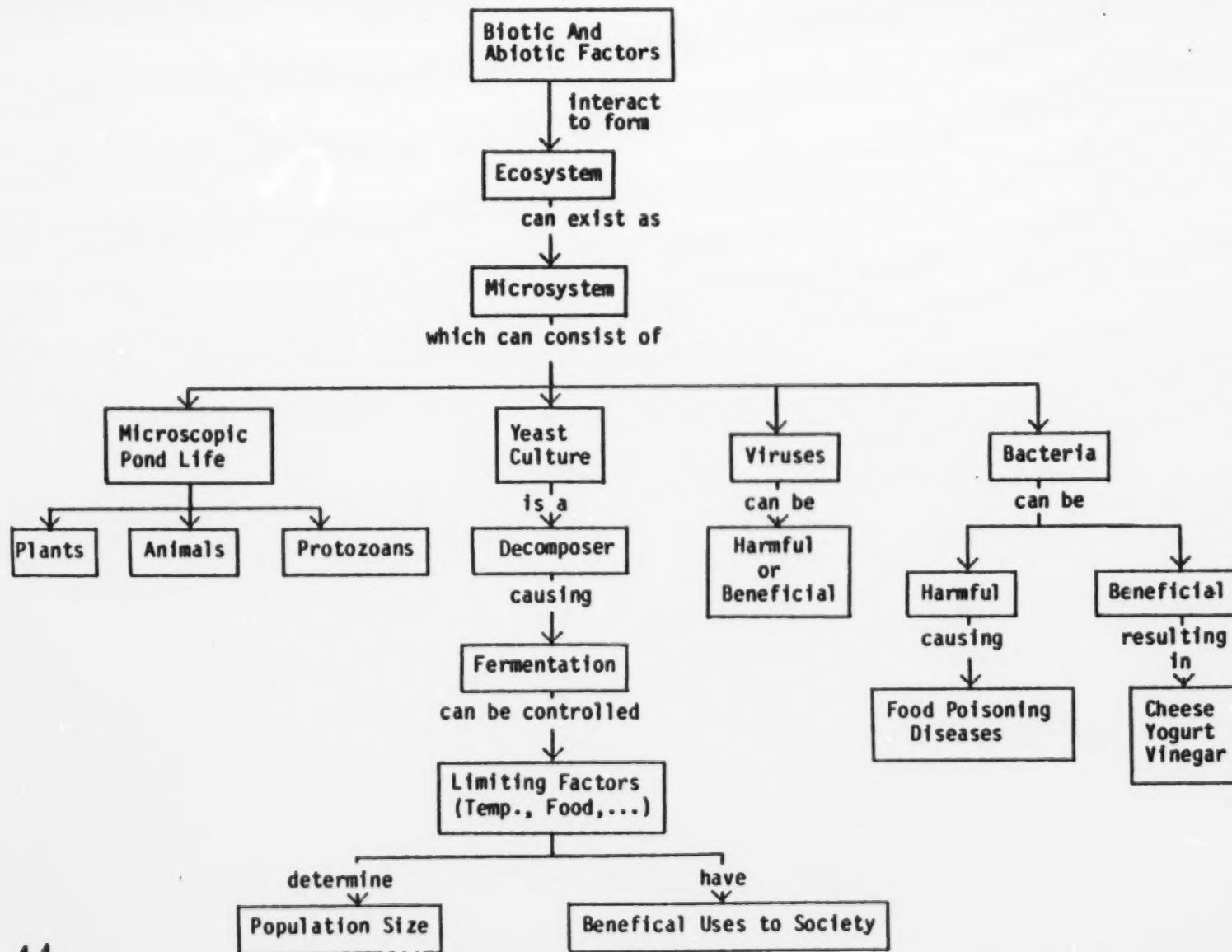
GRADE 7: CHANGES IN MATTER AND ENERGY: PHYSICAL PROPERTIES AND CHANGES OF MATTER



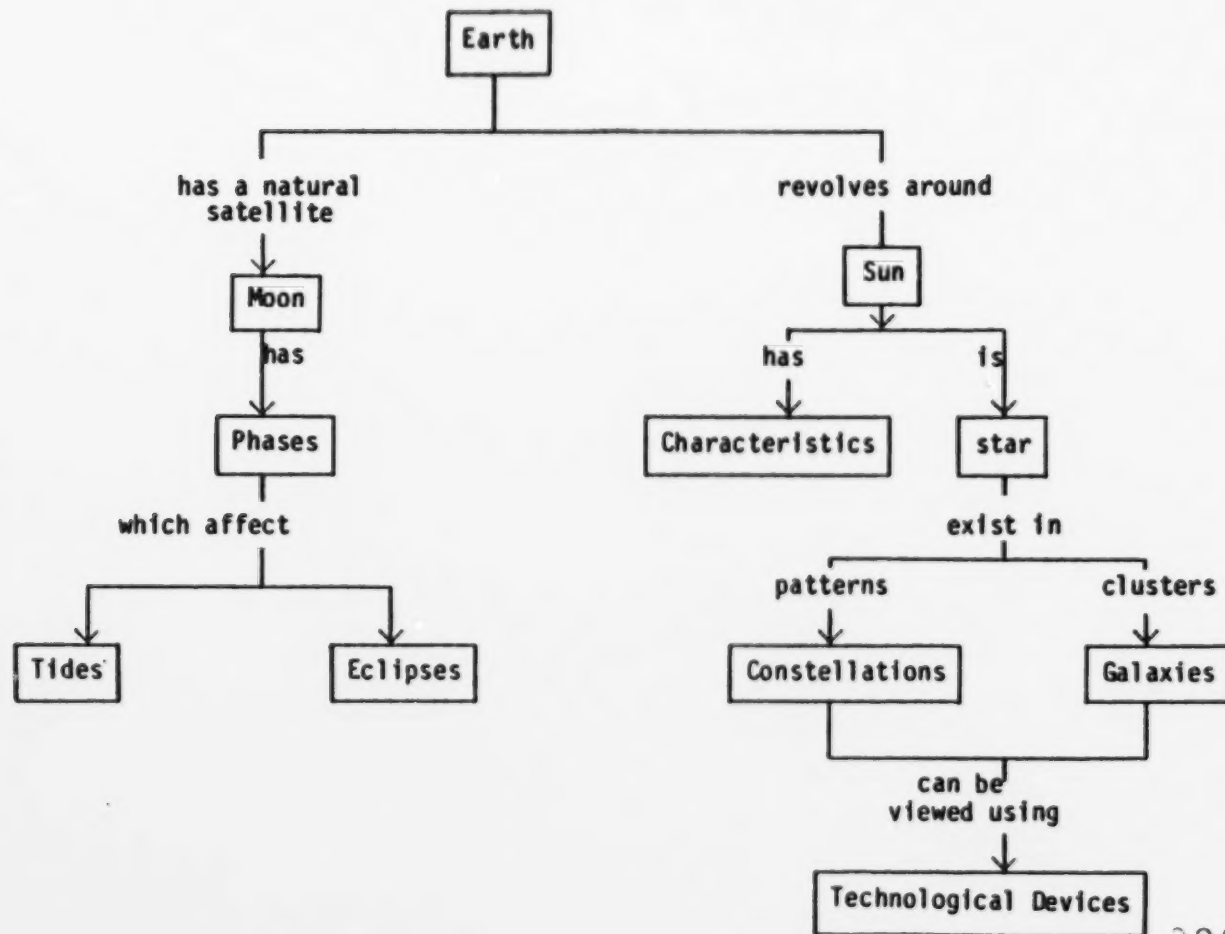
GRADE 7: CHANGES IN MATTER AND ENERGY: LIGHT



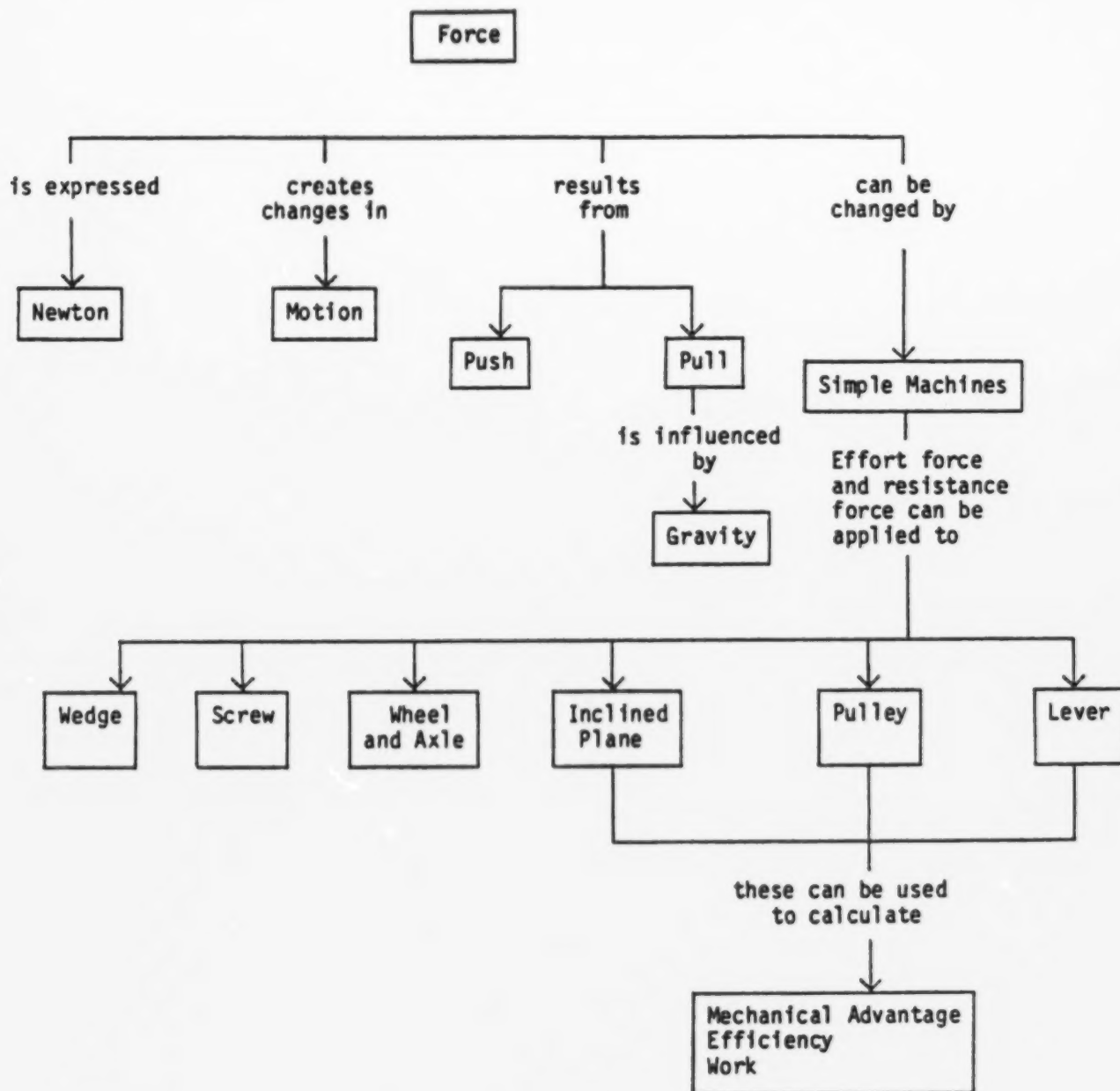
GRADE 7: ENVIRONMENTAL INTERDEPENDENCY AND INTERACTIONS AMONG ORGANISMS: MICROBES AND ECOSYSTEMS



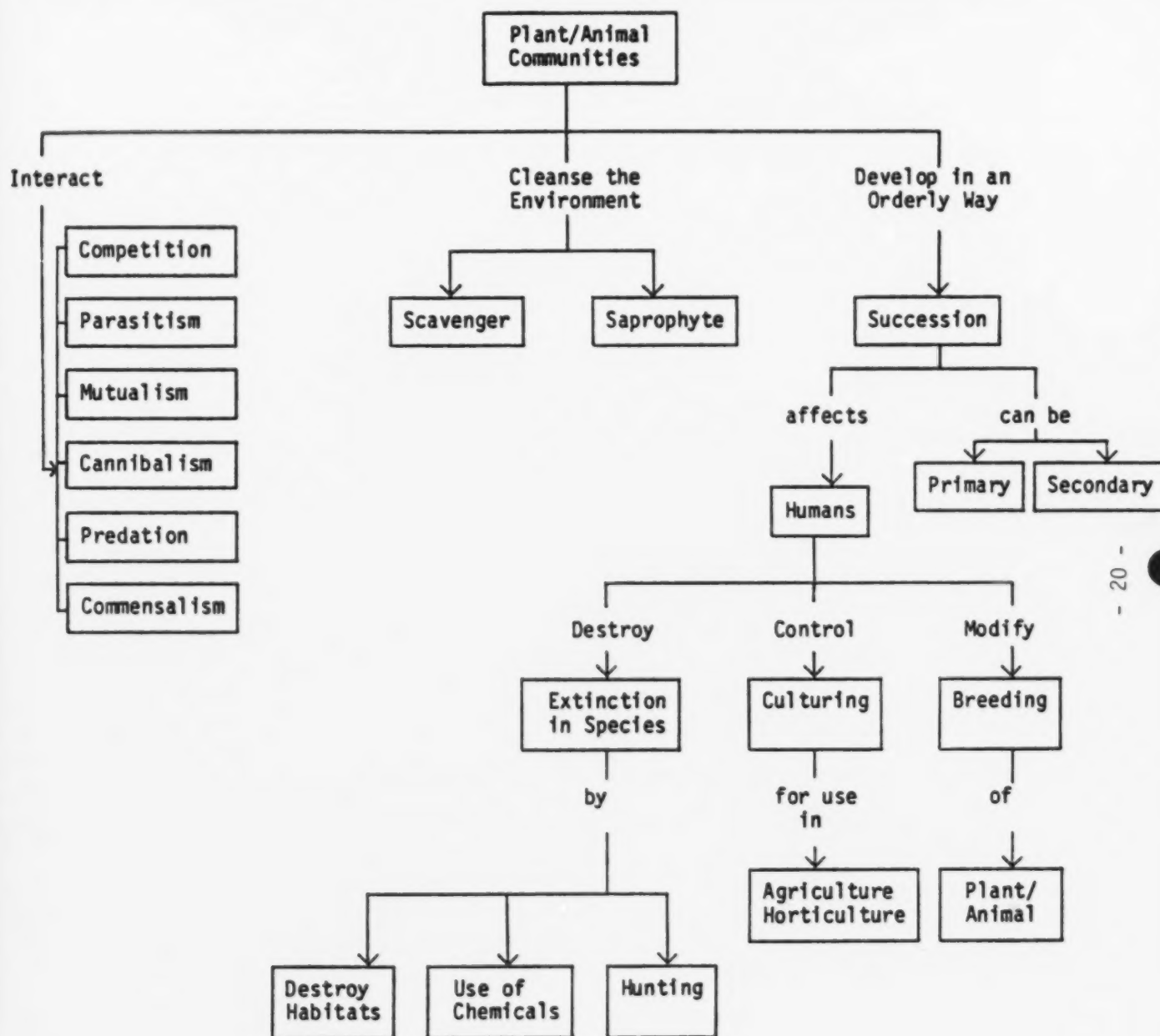
GRADE 7: EARTH, SPACE AND TIME: THE OBSERVABLE UNIVERSE



GRADE NINE: CHANGES IN MATTER AND ENERGY: FORCE—WORK AND MOTION

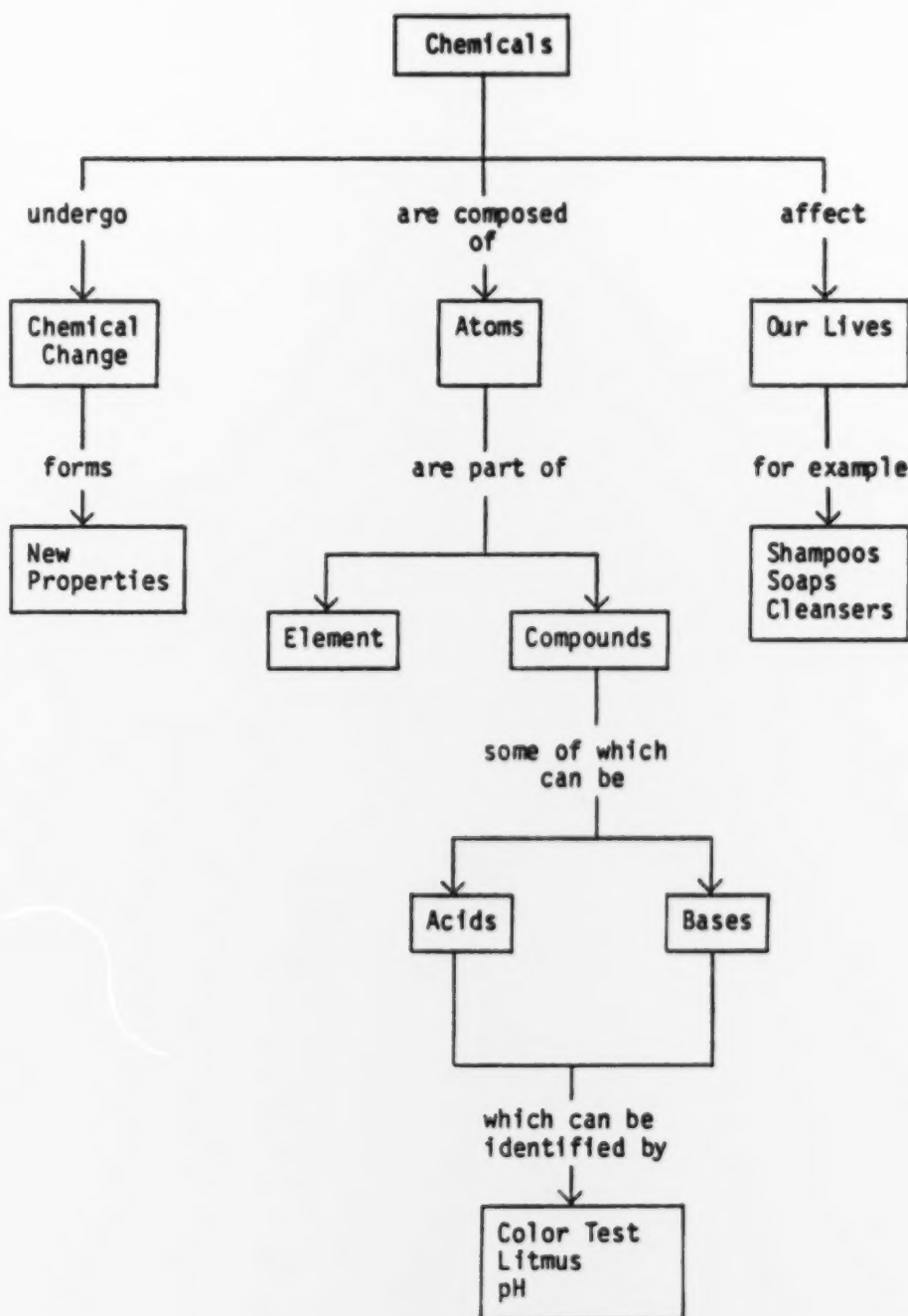


GRADE NINE: INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS: PLANT AND ANIMAL INTERACTION

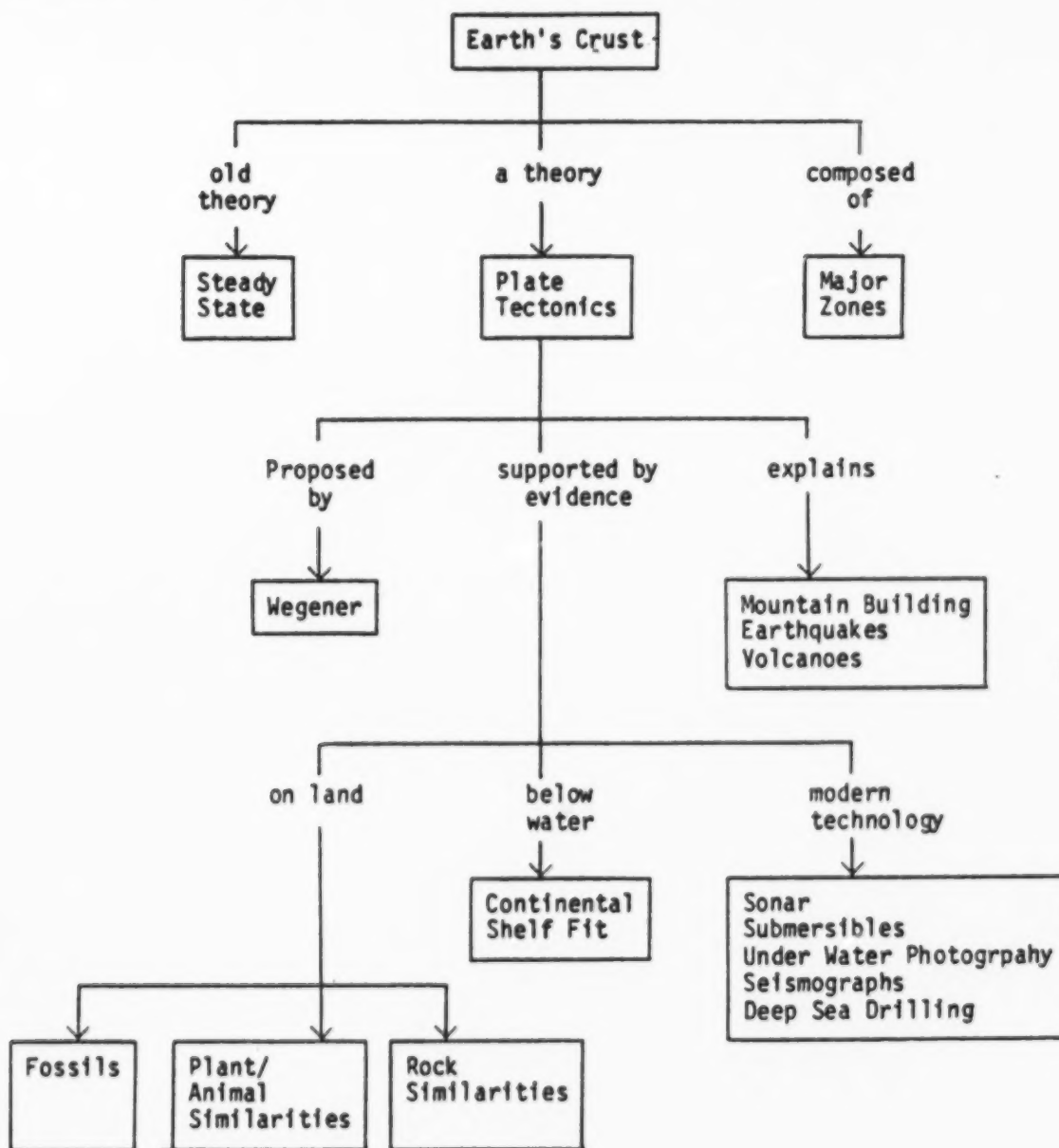


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GRADE NINE: CHANGES IN MATTER AND ENERGY: CHEMICAL INTERACTIONS

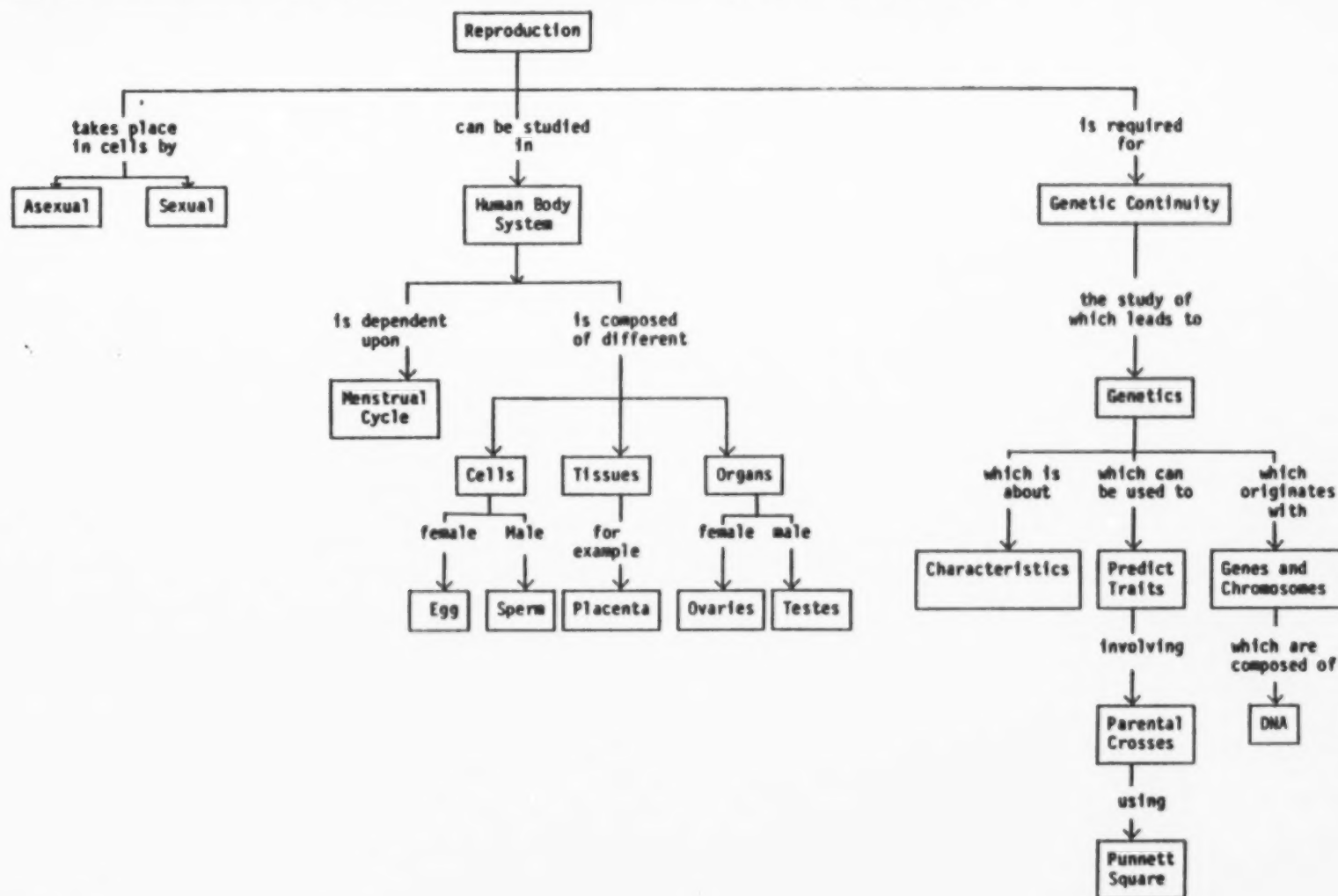


GRADE NINE: EARTH SPACE AND TIME: THE CHANGING EARTH'S CRUST



- 22 -

GRADE NINE: ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS: REPRODUCTION AND HEREDITY



ORGANIZING A SCIENCE PROGRAM

PROCESSES OF SCIENCE

Inquiry in science can be represented by specific intellectual skills entitled "processes." Processes are identifiable behaviours, used by scientists which can be generalized across content domains. These behaviors contribute to rational thinking in everyday affairs. In order to become an increasingly active and dynamic investigator of science the student needs to use the processes of the scientist. Through conscious, systematic development of these processes, the student will become increasingly better equipped for more complex learning in the fields of science as well as other areas of investigation.

Observing

Observing is one of the basic process skills of science. It involves obtaining information about objects, situations or events using the five senses. Observations may be qualitative or quantitative in nature. Observing provides both a basis for new inferences or hypotheses and a tool for testing existing inferences and hypotheses.

Measuring

Observations are quantified using non-standard and then standard units. Length, area, volume, mass, time intervals and force are among the measurements which are used. Appropriate measurement instruments and units within the metric system are selected. Examples of measurement include "using paper clips as standard units for measuring an object," "calibrating a scale," and "measuring the rate of hatching organisms."

Classifying

Classifying is the grouping of objects, concepts or events on the basis of some observable properties in order to show similarities, differences and/or inter-relationships.

Inferring

Inferring means suggesting more about a set of conditions than is observed. Inferences are based upon observed data and past experience. This may evolve from both direct and indirect evidence and are modified on the basis of new evidence. Examples of inference include "inferring the identity of objects on the basis of observing their shadows" and "inferring the kind of material (chemical) on the basis of evidence obtained from tests."

Predicting

A forecast is made about future events on the basis of ordered data. Predictions on the basis of ordered data, extrapolation beyond an observed pattern of events, and tests of predictions can be made. Examples of prediction include "predicting the appearances of adults that will grow from young animals" and "predicting the consequences of changes in an animal habitat."

Organizing and Processing Data (Communicating)

Organizing and processing data is a process that occurs between the observation stage and the interpretation or generalization stage. It usually involves the organization of "rough" data into a more compact and meaningful way (ordering, rearranging, comparing), depicting the data pictorially or graphically, and processing data mathematically (finding slopes, tangents, etc.) in order to facilitate interpretations.

Recognizing and Identifying a Problem

This process involves recognizing and focusing on problems that can be investigated. It also includes making assumptions about possible variables and the ability to delimit (narrow down) the question under investigation in order that one can proceed to work towards a solution or the ability to formulate and express relevant questions regarding living things, objects and physical events; and general relationships.

Identifying and Controlling Variables

Identifying and controlling variables involves the process of deciding which variables or factors will influence the outcome of an experiment, situation or event, and deliberately controlling all recognized variables in a systematic manner. That is, the independent (manipulated) variable is changed in a systematic way, corresponding changes in the dependent (responding) variable are observed and measured, and all other variables are held constant (controlled). This combination of relationships is referred to as a system. Examples of systems and related variables are a pendulum system where time of a swing is affected by length of the pendulum or an index card is moved a certain distance by the impact of a marble rolling down an inclined plane.

Hypothesizing

Hypothesizing is an "educated guess" about an expected relationship between two variables in an attempt to explain a cause and effect relationship. Hypotheses are based on observations or inferences about a set of events. A hypothesis should be testable; e.g., plants require light for growth.

Designing an Experiment

Experimenting is a cause and effect test between two variables. All processes may be involved. This can begin with setting a problem to be solved, identifying the variables to be controlled, making operational definitions, devising the test to be carried out and to follow the prescribed procedure.

Interpreting Data

Interpreting is the process by which sense is made out of the observations in the form of inferences, generalizations, or explanations: the generalizations are often a relationship between the independent (manipulated) and dependent (responding) variables. It usually is a direct response to the problem under investigation and, therefore, includes judgements about the interpretation, to fit with proposed hypotheses, and the limitation of the new knowledge. The explanation or generalization thus generated adds to the student's "body of knowledge" in science.

Defining Operationally

A process whereby objects or events are defined in a way which can be observed, used, or tested; e.g., the candle is out when a puff of smoke appears, or hot means any temperature over 60 degrees Celsius.

Formulating Models

This process involves the use of physical or mental models while describing the behaviour of something that is unfamiliar in terms of something whose behaviour is familiar. Constant vigilance is necessary to ascertain the validity (fit) of the model or analogy with the phenomenon modeled. Models often have to be revised in order to accommodate both old and new facts.

SCIENCE PROCESSES DEVELOPMENT

SCIENCE PROCESSES	GRADE	5	6	7	8	9
1. Recognizing and Identifying a Problem						
1.1 Recognize patterns and events		D	-----			
1.2 Delimiting and phrasing a problem		D	-----	E	----	
1.3 Identifying relevant and irrelevant information		D	-----			
2. Observing						
2.1 Use of the senses		D	-----			
2.2 Use of tools to assist observations		D	-----			
3. Measuring						
3.1 Use of instruments with precision		D	-----			
3.2 Construction of simple measuring devices (scales, hygrometers)		I	D	-----		
3.3 Verifying the accuracy of measuring devices		I	-----			
4. Classifying						
4.1 Comparing materials or data		D	-----			
4.2 Classifying and ordering based on a set of keys and criteria		D	-----			
5. Inferring						
5.1 Generalizing data		D	-----			
5.2 Determining adequacy of data as a basis for inferences		D	-----			
5.3 Inferring relationships					I	D
6. Communicating						
6.1 Use of traditional methods (drawing, graphs)		D	-----			
6.2 Mathematical treatment of data					I	D
6.3 Use of non-traditional or technological devices (tapes, discs, pictures)		D	-----			

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NOTE: Code - I - Introduced
D - Developed
E - Extend process - Student controlled and directed.

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SCIENCE PROCESSES	GRADE	5	6	7	8	9
7. <u>Predicting</u>						
7.1 Identifying and testing prediction	D-----					
7.2 Predicting quantitatively based on interpolation and extrapolation	D-----					
7.3 Predicting based on application of mathematical formula						I
8. <u>Controlling Variables</u>						
8.1 Identify relevant variables	D-----					
8.2 Identify the control variables					I	D
9. <u>Hypothesizing</u>						
9.1 Evaluate existing information	D-----					
9.2 Correctly state a hypothesis	D-----			E-----		
10. <u>Interpreting Data</u>						
10.1 Recognize valid interpretations	D-----					
10.2 Recognize limits of interpretations (staying within the data)	D-----					
10.3 Offer alternative explanations					I	D
11. <u>Define Operationally</u>						
11.1 Construct simple definitions based on experiences	D-----					
11.2 Use mathematical as well as verbal definitions					I	D
12. <u>Designing an Experiment</u>						
12.1 Select appropriate techniques	I	D-----				
12.2 Select appropriate techniques for observation and measurement	I	D-----				
12.3 Select appropriate techniques for recording of data	I	D-----				

NOTE: Code - I - Introduced
D - Developed
E - Extend process - student controlled and directed

SCIENCE PROCESSES	GRADE	5	6	7	8	9
13. <u>Formulating Models</u>						
13.1 Generate spatial models		I	D-----			
13.2 Generate mathematical models						I
13.3 Critically examine models						I

Note: Code - I - Introduced
D - Developed
E - Extend process - student controlled and directed

PROBLEM SOLVING AND SCIENCE, TECHNOLOGY AND SOCIETY

To prepare a student's facility in problem solving is a goal, which is generally found among today's curricula statements. Mathematics develops skills in analyzing quantitative data and spatial relationships as tools in problem solving; social studies promotes an understanding of documental evidence and the role of values in examining social problems; and technical-vocational studies provide opportunities to solve design and practical problems. Science education, when developing scientific processes and using inquiry within a scientific context, is emphasizing a problem solving approach.

Problem solving is sometimes considered to be the solution to a word problem whereby an obvious algorithm is available to the learner e.g. a type problem. Although this interpretation of problem solving may be useful in the development and application of certain concepts, for our purposes, problem solving is defined as a process whereby a student defines and seeks a solution to a recognized problem. As such, it is more open, a process of exploration and discovery, and the development and use of skills of experimentation and testing. Although no single method exists relative to the development of problem solving skills, the following skills⁶ are generally accepted in many problem solving models:

- . defining the problem in a resolvable form;
- . obtaining data;
- . organizing data;
- . analyzing data;
- . generalizing and synthesizing the data;
- . decision making.

⁶ Good, R. and Smith, M. "How do We Make Students Better Problems Solvers": Science Teacher, April, 1987, p.p. 31-6.

This general model can be applied in a variety of situations within the science program.

The nature of science-technology and its interaction with society offers a variety of opportunities for incorporating the goal of problem solving. The following examples indicate some possibilities:

- . The nature of science can be initially illustrated with younger children by using investigations with magnets or batteries and bulbs to develop process skills. With older students, the development of an understanding of the appropriateness or uncertainty of data and strategies of inquiry are an important part of problem solving.
- . The nature of technology and its interaction with ourselves provides a number of opportunities for developing problem solving skills. One possibility is that of resolving problems in the consumer area such as determining the best cleaning product or fabric. Designing and testing of potential technological solutions offers additional possibilities. For example, students could work with the problem of designing a simple bridge using a limited number of straws and testing its strength or constructing and testing the effectiveness of a solar cooker.

⁷ The University of the State of New York. Technology Education: Introduction to Technology; The State Education Department, Albany, N. Y., 1987.

⁸ McGregor Ann and Scott. Bridges: A Project Book Lothrop, Lee and Shephard Books, N.Y., 1980. Householder, D.L. and Marshall J. "An Introduction to Solar Energy" Industrial Education, September 1984.

SCIENCE, TECHNOLOGY AND SOCIETY

It is useful to consider science and technology as specialized and related problem solving processes. Science is the process that may be used to attempt to answer questions and provide knowledge about the universe and living things and materials in it. Technology is the process by which products and systems are developed to satisfy recognized needs. To design and make these products or systems, the findings of science are used. A Science, Technology and Society (STS) emphasis in the science program attempts to help students understand the applications of science and how this related to the world around them, making science more relevant.

For example, the given concept might be: a technological process or device often builds on past ones, becomes obsolete or can be changed and improved. Improvement may decrease the cost of the process. The program's objective would be: the student should be able to explain why some processes become obsolete. The activity would provide the student with the means by which the objective can be achieved.

Each STS activity in the 5-9 science program has been identified with two asterisks (**) beside it. Teachers are encouraged to find or develop other examples.

SUSTAINABLE DEVELOPMENT STRATEGIES

Sustainable development is the process of maintaining our natural heritage. It is important that students are made aware of the need for judicious use and management of our natural resources. The students are the stakeholders. They need to be informed about environmental concerns and the economic devastation which occurs due to a lack of environmental protection.

A Sustainable Development Strategies (SDS) emphasis in the science program will allow students to identify the areas in which environmental damage is taking place and to explore methods by which the environment can be protected. This SDS emphasis begins in kindergarten and continues throughout the entire science curriculum.

Some units lend themselves more to SDS activities and discussions than others. Teachers are encouraged to develop and foster SDS awareness whenever the opportunity arises.

This guide identifies the SDS related objectives with three asterisks (***) beside them.

5-9 PROGRAM OBJECTIVES: SCIENCE, TECHNOLOGY AND SOCIETY

OBJECTIVES	5	6	7	8	9
Students will be able to distinguish between science and technology _____	X	X	X	X	X
Identify scientific principles upon which a simple technology is based _____	X	X	X	X	X
Identify examples of interdependence of science and technology _____		X	X	X	X
Identify components of a functioning technological system with inputs, outputs, feedback, control _____	X	X	X	X	X
Describe how technological processes or devices are related to one another _____	X	X	X	X	X
Explain how technology extends the abilities of human beings _____	X	X	X	X	X
Explain why a technological process or device becomes absolute _____		X	X	X	X
Demonstrate how science, technology and society interrelate _____		X	X	X	X
Demonstrate that technology has improved standard of living _____	X	X	X	X	X
List examples of the impact of technology on jobs and careers _____			X	X	X
Recognize that science and technology alone cannot solve society's problems _____			X	X	X
Demonstrate that processes and devices are developed in response to needs _____	X	X	X	X	X
Demonstrate that certain processes or devices are not accepted because of attitudes _____		X		X	X
Report on the need for funds to support R & D _____				X	X
Identify advances in technological processes and devices that result in nations interacting as communities _____				X	X
Describe probable long and short term consequences of a technological process or device _____		X		X	X
Accept or reject a process or device based on advantages and disadvantages _____		X	X	X	X
Demonstrate that several solutions may exist to technological issues _____			X	X	X
Cite examples in which legislation has been passed to regulate a process or device _____				X	X

CODE: The "X" indicates the grade level in which activities relating to each objective can be found.

OBJECTIVES	5	6	7	8	9
Identify advances in technological processes and devices that result in nations interacting as communities _____				X	X
Describe probable long and short term consequences of a technological process or device _____		X		X	X
Accept or reject a process or device based on advantages and disadvantages _____		X	X	X	X
Demonstrate that several solutions may exist to technological issues _____			X	X	X
Cite examples in which legislation has been passed to regulate a process or device _____				X	X

CODE: The "X" indicates the grade level in which activities relating to each objective can be found.

NOTE: Refer to Appendix "E" for information on K-9 content: S.T.S.

IMPLEMENTATION: THE PRINCIPAL'S ROLE AND PROGRAM EVALUATION

Within a school board's plans for program evaluation and implementation, the principal of a school has an important leadership role. This role includes the following activities:

- . Encouraging a shared management plan of implementation for the science program by providing opportunities for cooperative planning.
- . Monitoring the degree of implementation and staff needs.
- . Determining the implications of the curriculum for staff training and facilities.
- . Providing easy access to the materials and facilities needed for the program.

Program Design Implications

- . Like the former design, the new science program is based on the assumption that a general science approach is more applicable to middle years students than a discipline-centred approach. The emphasis on the development of basic concepts and processes has been retained; however, a greater emphasis has been placed on problem solving and the relationship between science, technology and society. The program design implies that teachers of science should have a broad background in the sciences and endorse the interaction of science with the other areas of study.
- . The number of units per year have been decreased from the previous program in order to enable schools to increase the emphasis upon science, technology and problem solving; however, new units such as flight, microsystems, and the changing earth's crust may require specific kinds of in-service support.

- . Units such as reproduction and heredity (IX) and plant and animal interactions (IX) provide possibilities for integration with other areas of study. Provision of a plan for coordinating staff efforts would be important.

- . The program is based upon the premise that schools have sufficient equipment and materials to carry out the necessary activities. Provision of necessary equipment and facilities is critical and a source of funds should be available whereby teachers can easily obtain materials locally.

- . Materials will be developed and recommended to support the program. However, schools should continue to search for additional materials which may suggest different teaching emphases and offer different reading levels and student activities.

- . The system of measurement used in science courses is SI. By the end of Grade 8, students should know basic SI units in length, area, volume, mass, and speed, simple conversions such as mL to L and familiarity with the newton and joule. Maintaining an emphasis upon the use of these units in the sciences, as well as related disciplines, is necessary.

Program Evaluation

Evaluating the effectiveness of the science program and cooperatively, with teachers, determining methods of achieving the important curriculum objectives is a critical role of leadership. Many sources of data and approaches can be used, such as:

- . Evaluation of student achievement and analysis of the methods of evaluation.
- . Determining needed teaching strategies and relative emphases upon program goals, the implications and needs for new teachers or teachers from another subject area, and general teacher preparation.
- . Evaluation of the status of resource materials and facility needs.

Additional sources of information about program evaluation are:

Mechling, Kenneth R., "Taking Change: How Principals Can Improve School Science Programs," Principal January 1983, pp. 16-21; and,

Mechling, Kenneth R. and Oliver, Donna L., Promoting Science Among Principals: Handbook I-IV, National Science Teachers' Association, 1742 Connecticut Avenue, N.W., Washington, D.C., 1983.

STUDENT EVALUATION

The general purposes of student evaluation are to provide a) students with an understanding of their development and needs, b) teachers with a basis for planning necessary changes in teaching strategies and the curriculum, and c) information for parents and administrators. Evaluation should be related to program objectives and should consider a balance among science processes, manipulative and problem-solving skills, and content. Further, evaluation must be continuous and use a variety of approaches from informal observation of student activity to formal, such as achievement tests, performance (practical) items, checklists, and anecdotal records.

Some Evaluation Techniques

Informal observation techniques whereby teachers observe individual and group interactions in an activity can help to determine necessary skill development and the techniques required to improve these skills. Formal techniques include achievement (pencil and paper) tests and performance (laboratory) tests; checklists of processes, attitudes, and manipulative skills; and the examination of products such as oral presentations, reports and projects.

Partial Science Processes Checklist (5-9)

Monitoring student achievement in science processes may be helped by observing student behaviour in applying the processes. Samples of some behaviours are indicated in the following chart:

<u>Process</u>	<u>Checklist of Behaviour</u>
Measuring	Uses basic metric units as a standard; estimates, has basic concept of calibration (4-6). Uses simple measuring instruments with accuracy and precision; calibrates simple instruments; identifies appropriate standards for measuring lengths, area, volume and mass (7-9).
Classifying	Sorts objects into two sets on the basis of one property, two properties (4-6). Distinguishes between useful and relevant data, and irrelevant data; classifies a set of objects into two subsets; uses keys to identify objects and identify patterns (7-9).
Predicting	Predicts a change which is most likely to occur in a system after several observations; identifies a role for changes in a system; interpolates and extrapolates from simple graphs (4-6). Interpolates and extrapolates from more complex graphs; identifies or designs tests for predictions from data, begin to construct revisions of predictions based on additional information (7-9).

Manipulative Skills (Checklist)

Skill

- . Sets up and stores apparatus safely
- . Uses measuring instruments correctly
- . Safe use of apparatus
 - heating
 - testing of compounds, e.g., no tasting)

Sample Performance Items

These items may be used individually or in a group (station) setting to test process and manipulative skills:

Bouncing Balls

Purpose: To test observing, measuring, interpreting and inferential skills.

Procedure: Provide students with three different balls labelled A, B and C, three different surfaces (board, rubber, carpet), metre stick and masking tape. Ask students to find out which ball will bounce best on all surface area. Ask them to record how they are going to solve the problem, record data, and justify their conclusions.

Microscope

Purpose: To test microscope skills, safety skills and observational skills.

Procedure: Ask students to identify labelled parts, to focus the microscope on coloured threads on a glass slide and identify the colour of the top thread; focus on and draw a letter "e" drawn on the slide; and focus on a cell (identify some parts).

References

Doran, R.L. Basic Measurement and Evaluation of Science Instruction. National Science Teachers' Association, 1980.

Hedges, W.D. Testing and Evaluation for the Sciences in the Secondary School. Wadsworth Publishing Company, 1966.

ADD OTHERS

CONCEPT MAPS

A concept map is a means by which the organization of subject matter is represented by a diagram. It is a two dimensional device which shows not only the concepts but the relationships among them. The relationships are represented by the words on connecting lines.

The concept map shown at the beginning of each unit will provide the teacher with a tool to plan, teach and evaluate. Each concept map serves as a model and teachers are encouraged to develop their own concept maps.

MISCONCEPTIONS IN SCIENCE

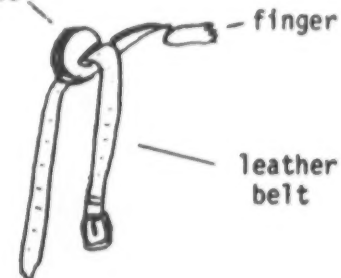
Misconceptions represent complete systems of explanations which are conceptually wrong. They are personal, in that students construct their own meanings from their own experiences. The misconceptions may seem incoherent to others, but the student doesn't see ideas as incoherent. The misconceptions are often stable; and even though new ideas are taught the old ones will remain. Some examples of misconceptions are:

- 1) that the mass of soil decreases as a plant is growing.
- 2) that molecules expand to make an object larger when it is being heated.
- 3) that the process of respiration is the breathing exchange of carbon dioxide and oxygen.

DISCREPANT EVENTS

A discrepant event involves a happening contrary to students' current beliefs.

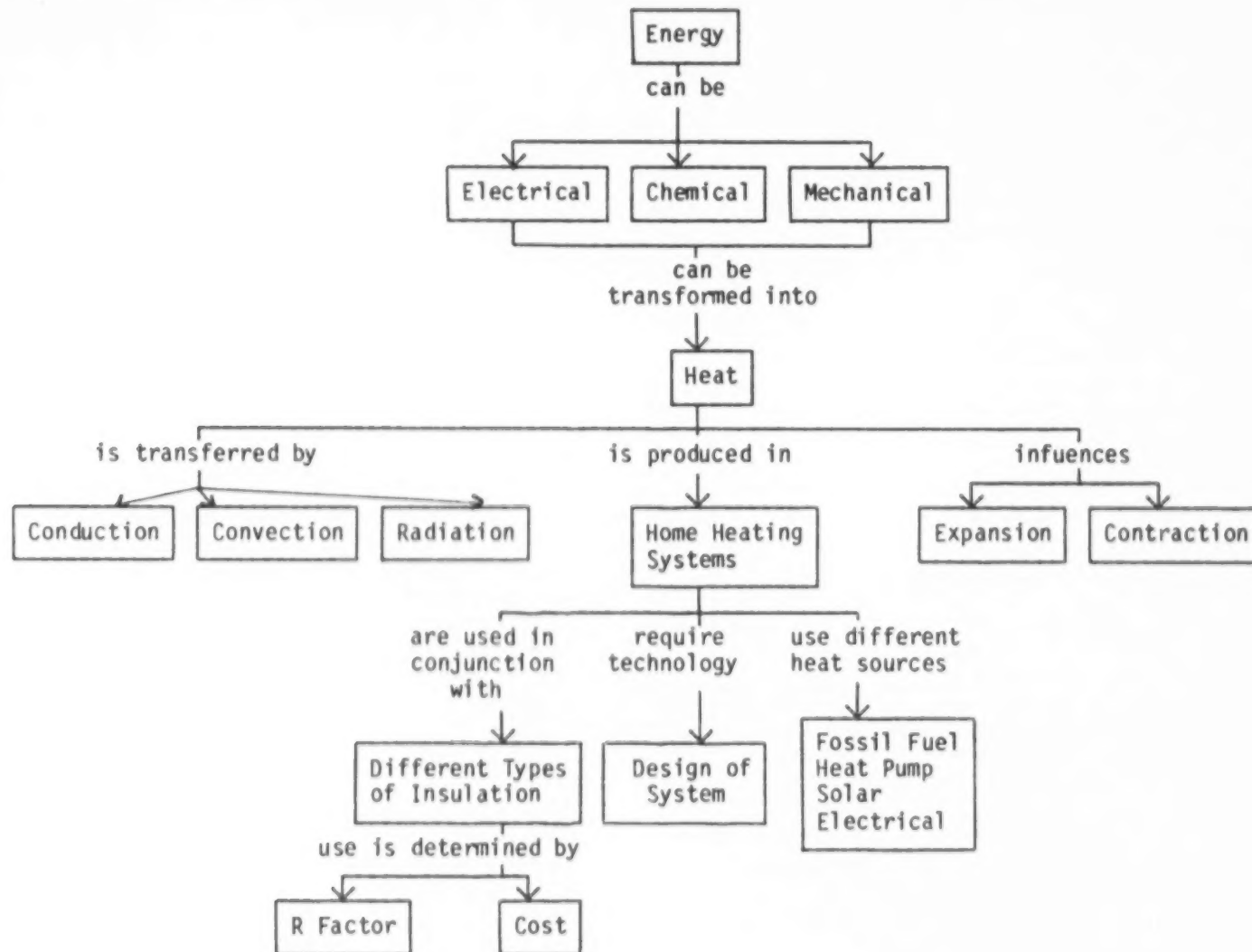
For example: groove in piece of wood



In this example, the students believe that the belt and the wooden stick cannot balance on the finger tip. This activity becomes motivational. It sparks their interest and gets students excited about science. When they see a discrepant event most students begin to wonder why and feel the need to have their questions answered.

Besides motivating students to learn scientific principles, discrepant events also provide a focus for fostering problem solving skills.

GRADE EIGHT: CHANGES IN MATTER AND ENERGY: HEAT



GRADE EIGHT: CHANGES IN MATTER AND ENERGY: HEAT

RATIONALE: Heat is a form of energy which can be transformed from other energy sources. Students will observe how heat is transferred by conduction, convection and radiation. The home heating system is composed of technological devices. There are alternatives to the use of fossil fuels for heat production.

- * Refers to Problem Solving
- ** Refers to STS
- *** Refers to SDS

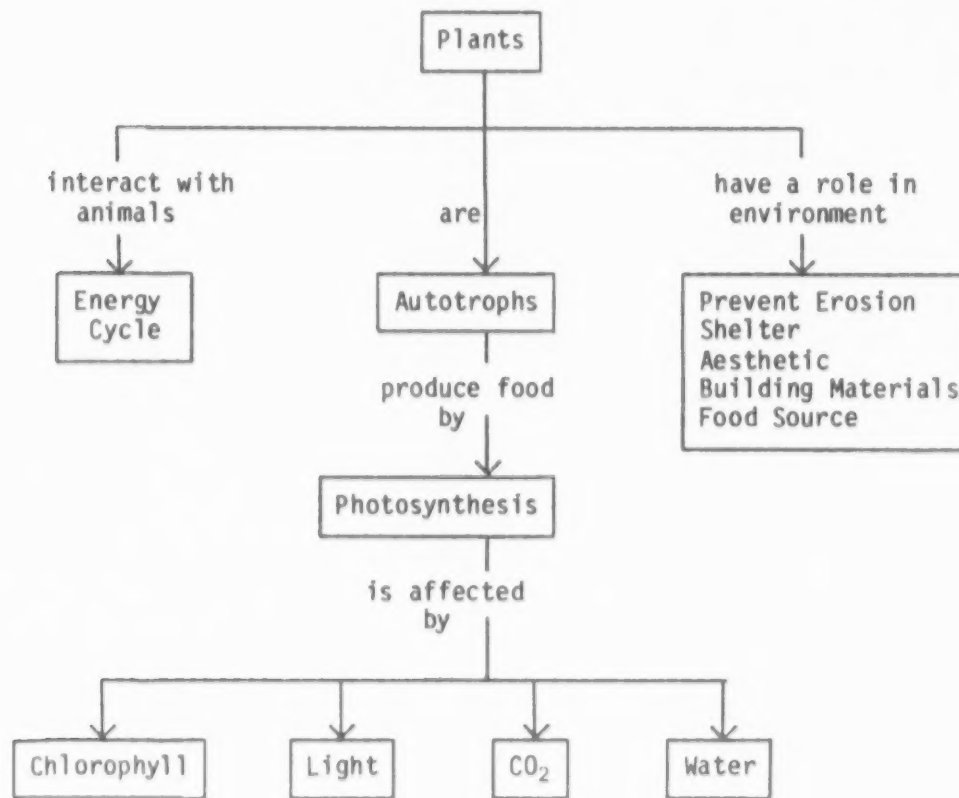
CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
	The student should be able to:	
1. Heat is a form of energy.	a) State heat as one form of energy.	Classroom discussion based on current literature.
2. Heat is a measure of total energy, depending on the temperature, mass and composition of matter. Temperature is a measure of the average kinetic energy.	a) Measure temperature increase when using varying masses of the same material. b) Measure temperature increase when the type of matter varies but mass is constant. c) Infer the difference between heat and temperature.	Fill one test tube 1/3 full and a second test tube one-half full of water. Record temperature. Place the test tubes into a water bath (60-70 ⁰) and record temperature after 10 minutes. Find the mass of sand which would fill a test tube one-third to one-half full. Place an equal mass (weight) of water into a second test tube. Record the temperature of sand and water. Place the test tubes into a water bath (60-70 ⁰) and record temperature after 10 minutes.
3. Heat can be transformed from other forms of energy.	a) Demonstrate heat production by friction.	Rub a metal rod with sandpaper. touch the rod before and after the activity and compare the sensations.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
	b) Demonstrate heat production by percussion.	Hammer a thin metal rod in the same spot for about 30 seconds. Make observations as in the previous activity.
	c) Demonstrate heat production by compression.	Use a plunger type tire pump and seal the needle valve with tape. Feel the hose after a few pumps.
	d) Measure temperature change in dissolving CaCl_2 . (Exothermic Reaction).	Start with 100 ml of cool water in a beaker, add a teaspoon full of CaCl_2 and stir. Record temperature and repeat adding more CaCl_2 .
	e) Demonstrate heat production by electric current. (Resistance).	Connect dry cell to light bulb. Touch the two wires which have been exposed and then feel the bare spot.
4. Heat can be transferred by conduction, convection and radiation.	a) Demonstrate heat conduction by measuring and recording time.	Use metal rod, wax and candle. Place a drop of wax at regular intervals along a metal rod. Apply heat to one end of the rod and record the time that elapses before each drop melts.
	b) Demonstrate that heat is conducted along a continuous or unbroken wire.	Use pieces of copper wire, corks and an alcohol burner. Stick a piece of copper wire into a cork. Heat the other end of the wire and note what occurs at the cork end.
	c) Demonstrate that heat can be transferred by convection.	Use a drop of India ink or methyl blue in a beaker of water. Slowly heat the water. Use two identical soda bottles. Fill one with warm water and invert it over the mouth of the other one which has been filled with coloured cold water. Then reverse the procedure.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
		Fill a test-tube 1/3 full of ice cubes and put a small rock on the ice. Add water until the test tube is almost full. Heat water to boiling.
	d) Construct a graph of temperature loss due to radiation.	Pour hot water into four jars, having one uncovered, one covered with paper, one covered with tin foil and one covered with tin foil and paper. Take temperature readings at regular intervals.
	e) Describe a number of home heating systems and compare their advantages and disadvantages.**	Make up a take home assignment about the home heating system.
	f) Discuss the importance of adequate ventilation in homes.	
	g) Define insulation as applied to heat.	Devise activities to check for R-factor, cost/benefit.
	h) Analyze and compare various forms of insulation.	
5. Heat causes expansion and contraction of matter.	a) Demonstrate that solids, liquids and gases expand when heated.**	Suggested activities: - dancing penny; - live balloon; - weakening wire; - rising juices; - curving tape.
86 6. Different metals expand at different rates.	a) Demonstrate the effect of heat on a bi-metallic strip.	Examine the bi-metallic strip (thermostat) as a technological system with feedbacks.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
	b) Infer why construction companies leave gaps between steel girders or between concrete sections of a road. **	
7. Heat pumps can be alternatives to fossil fuels as a heat source.	a) Describe how heat pumps can be an alternative to fossil fuels.**/***	Study information on heat pumps which can be obtained from heating contractors.
8. Solar energy can be an alternative to fossil fuel as a heat source.	a) Describe solar energy production.**/*** b) Discuss advantages and disadvantages of relying on solar energy.***	
9. Electricity as an alternative to fossil fuels as heat source.	a) Describe how electricity can be an alternative source for heat production.** b) Describe the possible role of electricity in heating Manitoba homes.** (availability, cost/benefit)	

GRADE EIGHT: ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS:
PLANTS AND THE TOTAL ENVIRONMENT



NOTE: Misconception: Soil Provides the mass of a plant.

GRADE EIGHT: ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS: PLANTS AND THE TOTAL ENVIRONMENT

RATIONALE: Plants are producers and are therefore essential in any energy cycle. By the process of photosynthesis the plants produce sugar. The students will examine the factors which interact during photosynthesis. Plants have other roles in an environment. The students will examine these roles, paying particular attention to the role of plants on human populations.

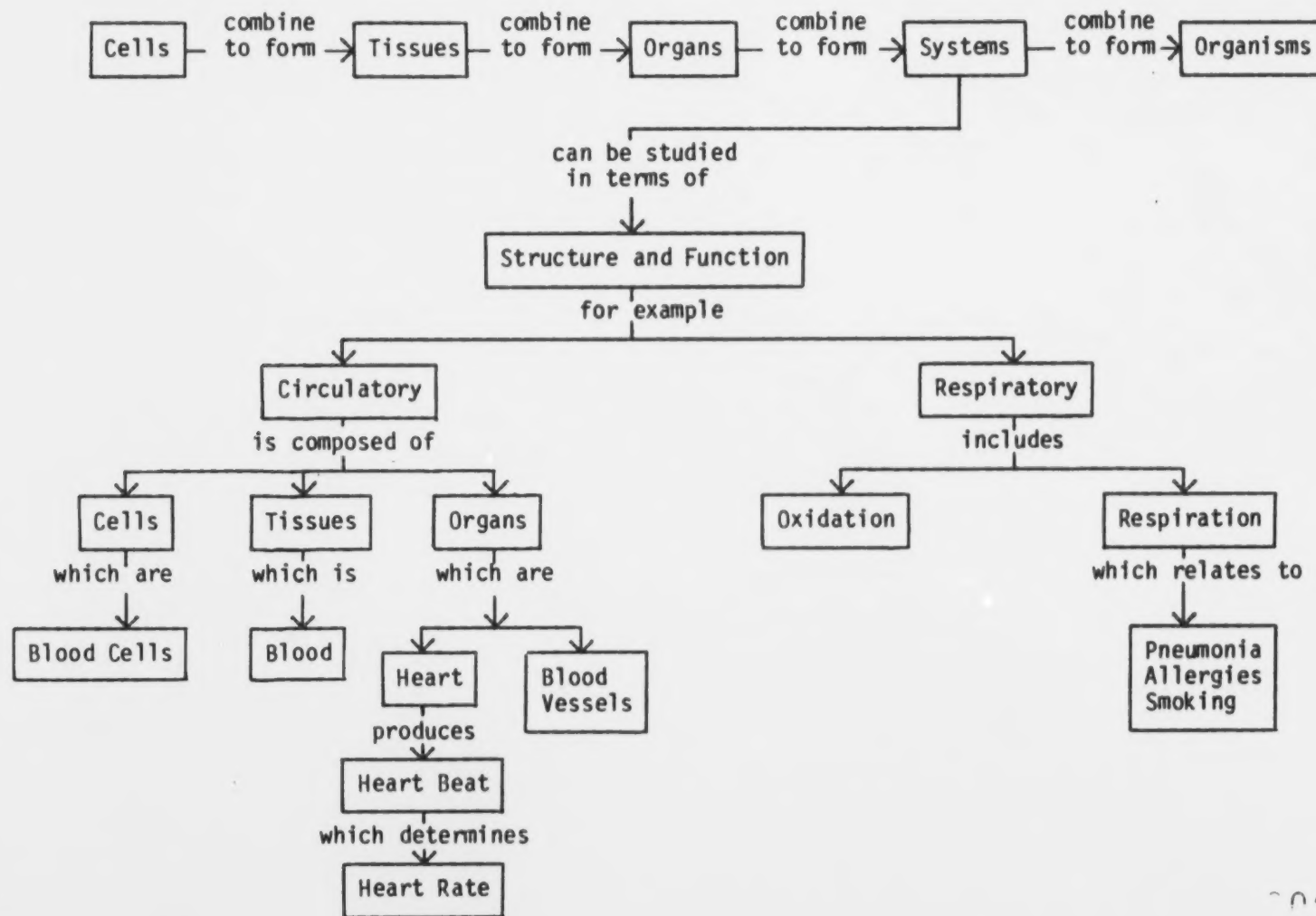
- * Refers to Problem Solving
- ** Refers to STS
- *** Refers to SDS

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
	The student should be able to:	
1. Plants and animals interact in an energy cycle.	a) Describe the energy cycle which exists between plants and animals.***	Classroom discussions based on presentation of the cycle. <u>Animals</u> $O_2 + \text{glucose}$ $\xrightarrow{\text{results in}}$ $\xleftarrow{\text{is used to produce}}$ <u>Plants</u> $CO_2 + H_2O$ Respiration Photosynthesis
2. Autotrophs produce their own food, heterotrophs are dependent on other sources.	a) Differentiate between autotrophs and heterotrophs.***	Class discussions. Identify plants as being autotrophs and animals as being heterotrophs.
3. The autotrophic process in plants is called photosynthesis.	a) Describe the process of photosynthesis.***	$6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$ Carbon + Water dioxide $\xrightarrow{\text{in the presence of light and chlorophyll}}$ results in sugar + oxygen

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
The energy from the sun is transformed into chemical energy.	b) Describe the transformation of energy from the sun.	Describe the transformation of light energy to chemical energy.
Chlorophyll, CO ₂ , water and light are factors involved in photosynthesis.	b) Design an experiment to test the role of light, water and carbon dioxide in photosynthesis.	Take two plants, cover one with an inverted glass jar so that air cannot enter, leave second exposed.
.	c) State the importance of chlorophyll in photosynthesis.	Discuss the spectrum and relate that red/green wavelengths are required.
The soil contributes very little to the total increase in the mass of plants.	d) Describe the role/importance of soil and water to photosynthesis.	Discuss the Van Helmont experiment. (Van Helmont proved that the soil did not solely contribute to the increase in mass of a plant. While a plant gained kg's mass, the total loss in mass of the soil was only grams.)
4. Respiration reaction is the opposite to photosynthesis.	a) Relate respiration to energy cycle.***	Discuss the reversible process of photosynthesis to obtain respiration.
5. Humans have many uses for plants in their environment.	a) Describe the role of plants in the environment:*** . Prevent soil erosion. . Retain water in soil. . Provide shelter and homes. . Landscaping. . Provide food. . Fuel.	Use pictures, books to arrive at other uses of plants. Examine a horticultural catalogue and discuss the use of plants in landscaping. <u>Note:</u> Students could develop a home landscape plan.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
6. Increased CO ₂ in the environment can create the Greenhouse Effect.	a) Describe the role of CO₂ in creating the Greenhouse Effect.*** b) Infer the changes to our ecology and environment that could bring about increased temperatures.**/***	Use books, pictures to describe the Greenhouse Effect. Group discussion to describe possible changes due to increased temperatures. Look at an atlas or globe and have the students project which areas might be effected when temperatures increase.

GRADE EIGHT: ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS: CELLS AND ORGAN SYSTEMS



GRADE EIGHT: ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS: CELLS AND ORGAN SYSTEMS

RATIONALE: To study the cell as a functioning unit of life. To show how different cells arrange into tissues and organs to become functioning organ systems in a complex organism. Study of the circulatory and respiratory system.

* Refers to Problem Solving

** Refers to STS

*** Refers to SDS

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
<u>Organization of Life</u>		
	The student should be able to:	
1. A cell is a functioning unit of life.	a) Define the cell as one functioning unit.	Note: If students have not been exposed to the microscope, carry out activities on proper microscope use. See microbes and microsystems, and appendix "k". Discuss the interaction between the cell and environment. In the discussion indicate the functions that a cell must perform: take in food, assimilate food, waste removal, sensitivity, movement, reproduce.
2. All cells are composed of three basic parts: cell membrane, cytoplasm and nucleus.	b) Identify some functions that each living cell must perform. a) Identify the cell structures found in human cheek cells.	Use prepared slides of animal cells.

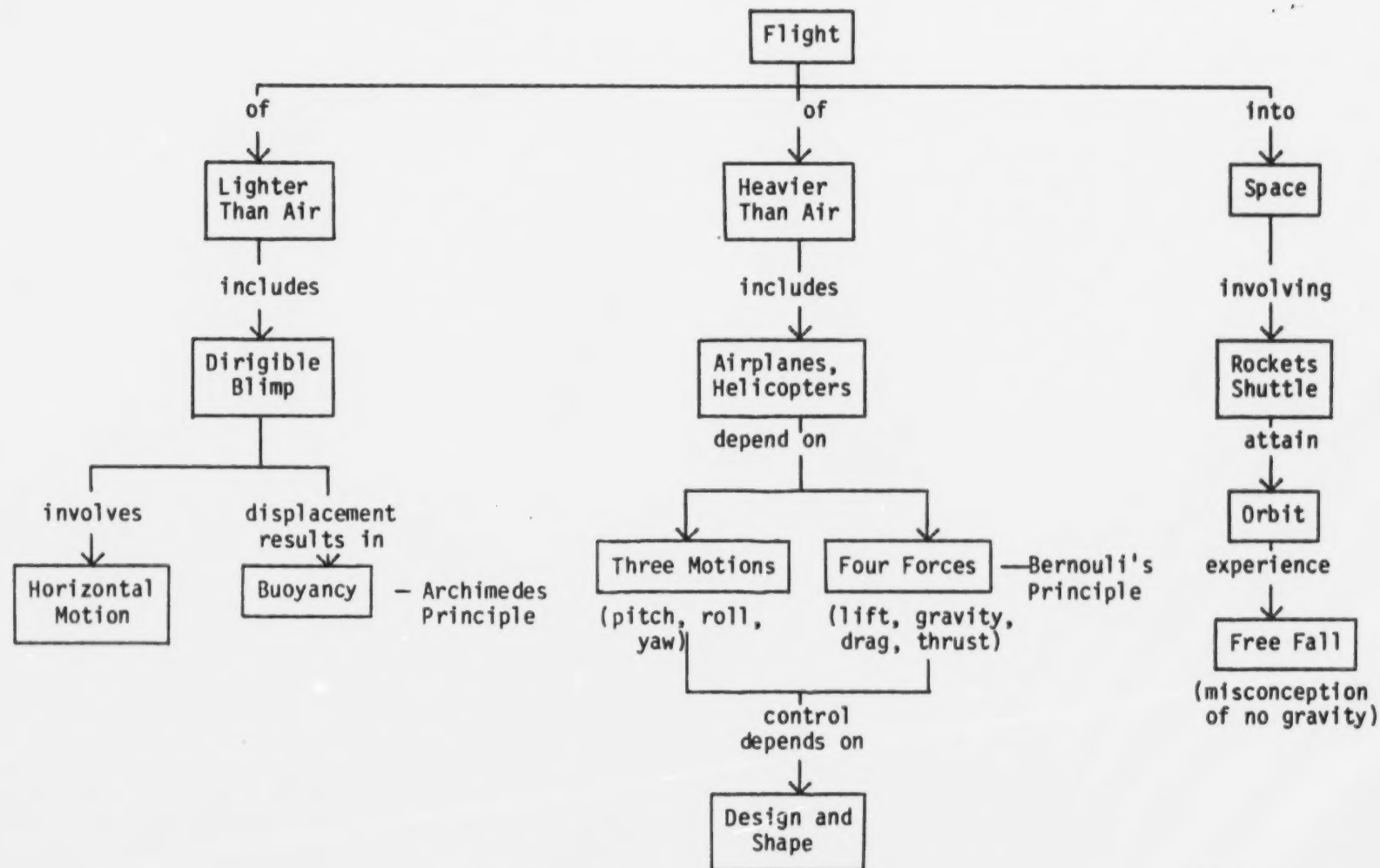
CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
	b) Describe the function of cell membrane, nucleus and cytoplasm.	Refer to diagrams and description of functions in reference books.
3. A plant cell also contains chloroplasts, cell wall and water vacuoles.	a) Identify the structures found in plant cells chloroplast, cell wall and water vacuoles.	Prepare and examine a microscope slide of onion cells or Elodea leaf.
	b) State the function of chloroplast and cell wall and water vacuole.	Refer to cell diagrams in reference sources.
	c) Compare and state the differences in structure and function between animal and plant cell.	
4. A complex organism is made up of cells, tissues, organs and organ systems.	a) Define the terms tissue, organ and organ system.	Refer to reference sources.
	b) State some examples of tissue, organ, organ system.	

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
<u>CIRCULATORY SYSTEMS</u>		
1. The circulatory system is required to transport materials throughout the body.	a) State the materials which are transported by the bloodstream.	Make a list of the materials which are transported by the bloodstream.
2. The circulatory system is composed of cells, tissues and organs.	a) Describe the structure and functions of blood components: . red cells . white cells . platelets . plasma b) Describe the structure and function of the blood vessels: . capillaries . arteries . veins c) Describe the structure of the heart.	Make a chart of the components of the blood and determine the structure and function of each. <u>Note</u> that blood is a tissue. Use charts and examine structure and function of the different vessels. Refer to the fact that each organ has specific tissue layers. <u>Example:</u> A capillary is epithelial only while an artery has three layers: epithelial, elastic and muscle.
3. Organs involved in the transport of blood are capillaries, veins, arteries and the heart.	a) Describe the path of blood as it passes through the heart. b) Describe the path taken by the blood as it travels from the heart to the body and back to the heart.	Dissect and examine a pork or beef heart. Refer to diagrams showing the circulatory systems.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/REFERENCES
4. The rate of heartbeat is dependent on activity.	a) Measure a person's pulse rate and describe the affect of activity on rate of heartbeat.	Do an activity on heartbeat. Check the heartbeat before and after exercise.
<u>RESPIRATION</u>		
1. Respiration is the combination of cellular oxidation and breathing.	a) Define cellular oxidation.	$C_6H_{12}O_6 + O_2 \longrightarrow CO_2 + H_2O + \text{Energy}$ Sugar + oxygen results in carbon dioxide + water + energy.
	b) Define breathing as process of inhalation and exhalation.	Do an activity on lung capacity.
2. Respiratory system is made up of nasal passages, trachea, bronchioles, alveoli, ribs, diaphragm.	a) State the function of nasal passage, trachea, bronchioles, alveoli, ribs and diaphragm.	Observe charts, and refer to reference materials.
3. The circulatory and respiratory systems are related.	a) State how the circulatory system interacts to the respiratory system.	
4. The respiratory system can be affected by:	a) Describe how each affects the respiratory system.***	Have students research information and report back to class on each topic. Discuss each topic.
a) Pneumonia		
b) Emphysema		
c) Influenza	a) Assemble and demonstrate the components of a cigarette.	Construct a Smoking Apparatus.
d) Allergies and hay fever	. Second-hand smoke.	
e) Smoking		

Note: Correlation--Science/Health. Heart, heart-disease in Health Curriculum, Grade 8.

GRADE EIGHT: CHANGES IN MATTER AND ENERGY: FLIGHT



GRADE EIGHT: CHANGES IN MATTER AND ENERGY: FLIGHT

RATIONALE: Flight in air is a precursor to flight in space. There are two types of flight in air: lighter-than-air flight and heavier-than-air flight. This unit stresses the ideas of buoyancy, design, gravitational pull, and thrust as they apply to flight.

* Refers to Problem Solving

** Refers to STS

*** Refers to SDS

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
<u>Lighter-than-Air Flight</u>		
	The student should be able to:	
1. Air is a fluid, as is water.	a) Define buoyancy.	Have students develop a definition such as "the force that pushes an object up." <u>Note:</u> The upward buoyant force of a fluid opposes the downward force of gravity on an object.
	b) Observe whether objects of different densities will sink or float in water.	Fill a pan with water. Demonstrate if objects such as wood, paper, metal rods will sink or float. Stress that the same principles of density that apply to water will apply to air. (Review) <u>Note:</u> An object will float when the density is the same as the medium in which it is found (balance).
110 2. Vertical flight of a lighter-than-air device may be controlled.	a) Devise an experiment which will float a balloon at a specific height above the floor.	Use a balloon filled with helium. Attach a string to the balloon and attach paper clips to the balloon. The floatation can be controlled by increasing or decreasing the number of clips.

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CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
	b) Infer that the density of air decreases as the altitude increases.	Students should infer that the density of the air is greater near the floor because more weight added to the string results in floatation at a lower altitude.
3. Horizontal flight of a lighter-than-air device cannot be controlled without the addition of an engine.	a) Discuss why a balloon's horizontal movement is dependent on wind. b) Infer that an engine or some device which can create or change direction of force is required on an airship (dirigible). c) Infer that the design must be oval or circular and streamlined. d) Discuss uses of lighter-than-air aircrafts.	Use a fan to control the horizontal movement of a floating balloon. Discussion Topic: What would be the advantages or disadvantages of having rectangular or square airships? Pictures of Goodyear Blimp.
<u>Heavier-than-Air Flight</u>		
1. Heavier-than-air crafts include gliders, airplanes, helicopters, spacecraft.	a) List craft which fly and are heavier-than-air.	Collection of pictures of various types of heavier-than-air crafts.
2. The four forces acting on heavier-than-air flight are lift, weight or gravity, drag and thrust.	a) Define lift. b) Demonstrate lift using a strip of paper (Bernouillis Principle).	Hold a piece of paper along one edge. Blow across the top of the paper and observe how it lifts.

CONCEPTUAL STRUCTURE

OBJECTIVES

ACTIVITIES/RESOURCES

3. Gravity is a force which opposes lift.

a) Infer that gravity is the opposing force to lift.

4. Drag is the resistance of the air.

a) Define drag.

b) Test different shapes and designs to withstand drag. Record the time taken to fall to the floor.

Hold the paper in front of a fan to demonstrate that lift increases as air movement across the top increases.

Have the students stand on a stool and release a flat piece of paper. Observe and record the length of time needed to fall to the floor.

The students can shape or design the paper in any way they wish by fastening the edges with paper clips. The designs will be released and time recorded for them to reach the floor.

Note: The cone shapes should fall the fastest.

5. Thrust is the force which balances or overcomes drag.

a) Infer that the thrust must be greater than the drag, if forward motion is to occur.

6. The design of the aircraft is important to achieve efficient heavier-than-air flight.

a) Design heavier-than-air airplanes out of paper, balsa wood, plastic.**

The students can construct and test their airplanes for flight. Encourage them to use both conventional and non-conventional designs.

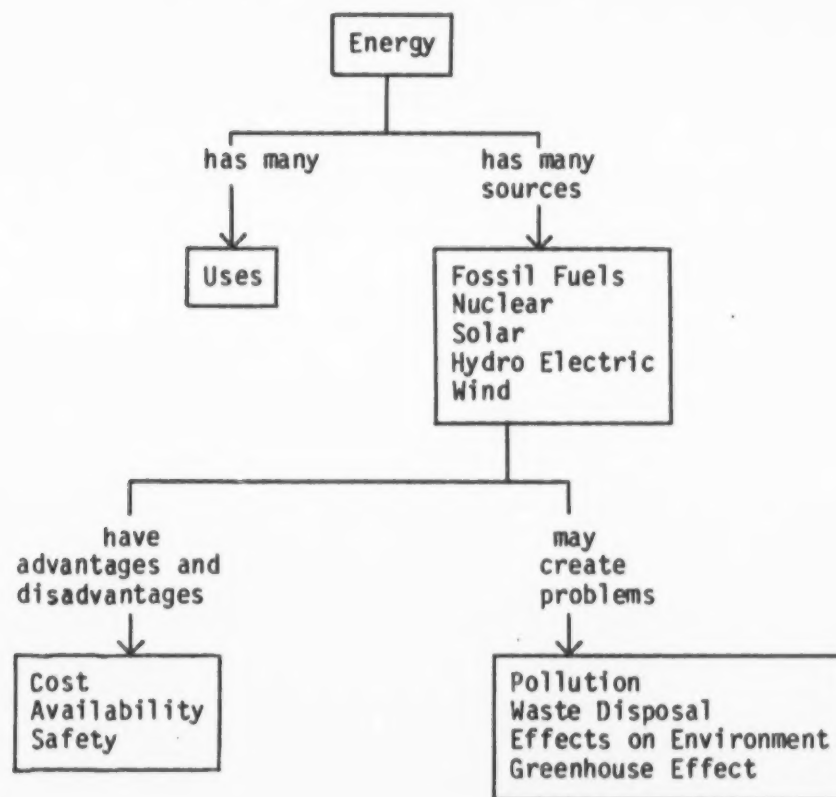
Note: The airplanes will be designed as to:
 . air foil shapes,
 . spoilers,
 . flaps,
 . wing fences,
 . angle of incidence for wings.

Flight is possible when the three basic motions are controlled.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
7. Pitch is the up and down motion of the nose. This motion is controlled by elevators.	a) Define pitch and elevator. b) Observe that pitch can be controlled by elevators.	Develop definitions such as: Pitch is the up and down movement of the nose of the plane. Elevators are hinged flaps on the horizontal part of the aircraft's tail. Observe the flight of an airplane (students) when the elevators are up or down.
8. Roll is the up and down motion of the wing tips. They are controlled by ailerons.	a) Define roll and aileron. b) Observe the flight of the airplane when the ailerons are raised or lowered.	Develop definitions such as: Students will add ailerons to their airplanes and observe flight patterns when the ailerons are raised or lowered.
9. Yaw is the turning motion of the aircraft and is controlled by the rudder.	a) Define yaw, rudder. b) Observe the flight of an airplane when the rudder is pushed to the left or to the right.	Develop definitions such as: Students will add a rudder to their airplanes and observe flight when the rudder position is changed.
10. Airplane design and construction has changed.	a) Compare airplane design of the past with the present.** b) Predict what aircraft of the future may look like.**	Use pictures, aviation books. Correlate with art classes.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
<u>Flight in Space</u>		
1. Spacecraft differ from conventional airplanes.	a) Compare and contrast the spacecraft and the airplane: . design of the craft engines required to produce the thrust, . size and payload of the craft, . purpose of the crafts.**	Use pictures of airplanes, rockets, shuttle with boosters. Find the similarities and the obvious differences between these crafts. Students may build small rockets with CO ₂ launchers.
2. The revolution or orbit of the spacecraft, depends upon gravity, orbital speed and altitude of the orbit.	a) Describe how a spacecraft attains and maintains an orbit.** b) Infer the interaction of gravity, orbital speed and altitude of the orbit.	
3. In orbit, the space vehicle is in free fall.	a) Define free fall. b) List examples of free fall experiences on Earth.	Note: Free fall is the period during which a falling body is not affected by anything except the pull of gravity. Have students develop a list including examples such as: the period of time which elapses from the time a parachutist steps out of an airplane, to the time that the parachute opens. Note: Students have the misconception that an orbiting vehicle is weightless, whereas it still has approximately 94 percent pull of Earth's gravity.

GRADE EIGHT: CHANGES IN MATTER AND ENERGY: ALTERNATIVE FORMS OF ENERGY



GRADE EIGHT: CHANGES IN MATTER AND ENERGY: ALTERNATIVE FORMS OF ENERGY

RATIONALE: The demand for energy is continuously increasing as the population of the world and technology increases. However, the supply of energy resources is not keeping pace with the demand. Alternative sources of energy will have to be developed and used. The use of alternative sources of energy is not without risk or problems. Resources and the environment must be kept in balance.

* Refers to Problem Solving

** Refers to STS

*** Refers to SDS

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
	The student should be able to:	
1. Energy is used in our daily lives.	a) List the ways that energy is used daily.	Students will list the different ways that energy is used around home, school and community.
	b) Identify the source of energy that is used.	Identify the sources as to fossil fuel, electrical, etc.
2. Energy sources may be renewable or non-renewable.	a) Differentiate between renewable and non-renewable resources.***	Teachers can provide pictures of power dams, windmills, oil rigs and gas pumps, solar collectors.
	b) Categorize the sources of energy as being renewable or non-renewable.***	
3. Fossil fuels are non-renewable sources of energy.	a) Define fossil fuel.	Students should be able to state how fossil fuel was formed and that fossil fuel may exist as oil, natural gas or coal.
	b) Discuss the use of fossil fuels in daily lives.**/**	Stress the use of fuels in combustion--cars and homes. Incomplete combustion results in air pollutants.
	c) Identify regions in Manitoba and in Canada where fossil fuels are found.**/**	A map of Manitoba (Canada) can be provided and students will mark the areas where fossil fuels are found and removed.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
4. Extensive use of fossil fuels may cause pollution.	a) Discuss how the gases given off from combustion and incomplete combustion of fossil fuels affect the environment:**/** . acid rain, . greenhouse effect, . air pollution.	Have students gather information on these topics and make reports for the class.
5. Nuclear energy is an alternative form of energy.	a) Describe how a nuclear reactor works:**/** . fission, . fusion. b) List some advantages of using nuclear energy as opposed to fossil fuels.** c) Discuss the major problems of nuclear plants, radioactive wastes.**/**	The description should be simple. Stress that the reactor is a part of a system. Resources from Pinawa are recommended. Contact Atomic Energy at Pinawa to see if a tour can be arranged. Make students aware of less fuel needed, less cost, less transportation of energy, fewer harmful gases. Discussion on how the wastes will be removed and where they will be stored.
6. Solar energy is a continuous flow energy source.	a) Define solar energy. b) Differentiate between passive and active solar energy.**	Use reference sources. Textbook Note: With the active system, collectors, storage units, circulation systems are required. This means a greater cost to supply the energy.
7. Solar cell converts solar energy to electrical energy.	a) Discuss the advantages and disadvantages of producing electricity from solar energy.**	Use reference sources.

CONCEPTUAL STRUCTURE	OBJECTIVES	ACTIVITIES/RESOURCES
8. Hydroelectric energy is a viable alternative for Manitoba.	a) Describe how falling water is used to produce electricity.*** b) Identify the regions in Manitoba where hydro-electric plants are in existence or being built.*** c) Discuss advantages and disadvantages of hydro-electric energy.***	Use of pictures and brief description. Use maps to show the rivers where dams are found.
9. Wind energy may be an alternative.	a) Describe how the wind can be a source of energy. b) Discuss advantages and disadvantages of wind energy.***	Look at pictures of windmills. Stress the transformation of wind energy into electrical energy.
<u>Enrichment</u>		
1. Active solar system can be an alternative energy source.	a) Design a miniature building (house) which will have an active or passive solar system.**/**	
2. The cost of an energy source may determine if that source can be a viable alternative.	a) Compare the cost-benefit of using several sources of energy.**/**	Information can be obtained from Energy Manitoba.

APPENDIX "A"

GENERAL PROGRAM OVERVIEW K-4

THEMES	K	1	2	3	4
ENVIRONMENTAL INTERDEPENDENCY AND INTERACTION AMONG ORGANISMS	LIVING AND NON-LIVING	ANIMALS AS LIVING ORGANISMS	LIVING ORGANISMS IN THE ENVIRONMENT	LIFE CYCLES	POPULATION INTERACTIONS
		PEOPLE ARE LIVING ORGANISMS			
CHANGES IN MATTER AND ENERGY	PROPERTIES OF OBJECTS	PROPERTIES OF MATTER	FLOTATION: A PROPERTY: OR MATTER	CHANGES IN MATTER	ELECTRICITY
				ENERGY, HEAT AND TEMPERATURES	SOUND
				AIR AND AIR PRESSURE	STRUCTURES
EARTH, SPACE AND TIME	SIZE, POSITION AND TIME	COMPARING AND MEASURING EVENTS	MEASURING TIME, OBJECTS AND POSITION	THE EARTH, SUN AND MOON	WATER AND LAND
			LIGHT AND SHADOWS		

APPENDIX "A"

GENERAL PROGRAM OVERVIEW 5-9

5	6	7	8	9
ADAPTATIONS TO ENVIRONMENT	INTERACTIONS OF POPULATIONS WITH ENVIRONMENT	MICROBES AND ECOSYSTEMS	CELLS AND ORGAN SYSTEMS ----- PLANTS AND THE ENVIRONMENT	REPRODUCTION AND HEREDITY ----- PLANT AND ANIMAL INTERACTIONS
ELECTRIC CHARGES	FORCE AND MOTION	LIGHT	HEAT	FORCE, WORK AND MOTION
----- FORCE AND MOTION ----- PHYSICAL AND CHEMICAL CHANGE	SIMPLE MACHINES	PHYSICAL PROPERTIES AND PHYSICAL CHANGES OF MATTER	ALTERNATIVE FORMS OF ENERGY ----- FLIGHT	CHEMICAL INTERACTIONS
THE CHANGING EARTH	WEATHER ----- THE EARTH IN SPACE	ROCKS, MINERALS AND SOILS ----- THE OBSERVABLE UNIVERSE		CHANGING EARTH'S CRUST

APPENDIX "B"

SCIENCE PROCESSES DEVELOPMENT: K-9

PROCESSES	K-3	4-6	7-9
1.0 Observing			
1.1 Identity and state properties and changes in an object using senses _____	ID	D	E
and events _____	ID	E	E
1.3 Identify and describe elements of a system, motion of an object relative to a reference point _____	I	D	E
1.4 Distinguish between qualitative and quantitative observations _____		ID	E
1.5 Distinguish between observation and inference _____		I	DE
2.0 Measuring			
2.1 Select and use appropriate instruments with precision. Use SI _____	I	ID	ID
2.2 Design and construct simple measuring devices (measuring time, scales, hygrometers) _____		I	I
2.3 Calculate the efficiency of simple machines _____			ID
3.0 Classifying			
3.1 Distinguish between objective and subjective information, fact and inference _____			ID
3.2 Sort objects into groups according to similarities and differences and/or quantitative measurements _____		I	ID DE
3.3 Develop classification systems _____		I	I ID
3.4 Use a dichotomous key _____			I

CODE: I - Introduced to a limited degree.
 D - Developed into new areas or in more complex forms.
 E - Extend process (student controlled and directed).

SCIENCE PROCESSES DEVELOPMENT: K-9

PROCESSES	K-3 4-6 7-9
4.0 <u>Inferring</u>	
4.1 Identify observations which support an inference _____	I ID DE
4.2 Describe additional observations needed to test alternative inferences _____	I ID DE
4.3 Identify inferences that should be accepted, rejected or modified on the basis of additional observations _____	ID DE
5.0 <u>Communicating</u>	
5.1 Describe and sequence a series of events orally or in writing _____	ID DE E
5.2 Construct a simple data table or graph _____	I DE E
5.3 Construct a line graph and represent principles using a mathematical format _____	ID D
5.4 Write an accurate report describing events _____	I D
6.0 <u>Predicting</u>	
6.1 Make and confirm simple predictions using an activity _____	ID E E
6.2 Predict the consequences of removing or altering one or more system-components _____	ID DE
6.3 Interpolate and extrapolate from patterns or graphs; predict from formulae _____	I D
6.4 Design tests for predictions; maintain, remove, or modify predictions _____	I DE

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SCIENCE PROCESSES DEVELOPMENT: K-9

PROCESSES	K-3	4-6	7-9
7.0 <u>Interpreting Data</u>			
7.1 Distinguish between relevant and irrelevant data using observation, reading, or listening _____	I	ID	DE
7.2 Recognize limits of data, biases and their distortions _____		I	D
7.3 Interpret cause and effect relationship within a problem solving situation, construct inferences from data _____		I	D
8.0 <u>Recognizing and Identify a Problem</u>			
8.1 Recognize patterns and events _____	I	D	D
8.2 Delimiting and phrasing a problem _____		ID	DE
9.0 <u>Controlling Variables</u>			
9.1 Identify relevant variables manipulated and responding to test a given hypothesis _____		ID	DE
9.2 Examine collected data and select relevant data _____		I	D
9.3 Identify variables (manipulated and responding from observations) _____			ID
10.0 <u>Hypothesizing</u>			
10.1 Distinguish between a) opinion and hypotheses _____		I	D
b) hypotheses, theory and law _____			ID
c) inferences and hypotheses _____			D
10.2 Identify a testable hypothesis and revise when indicated by data _____		I	DE

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SCIENCE PROCESSES DEVELOPMENT: K-9

PROCESSES		K-3	4-6	7-9
<u>11.0 Operational Definitions</u>				
11.1	Construct definitions on the basis of changes which occur or what an object does or how it is used		ID	DE
11.2	Contrast an operational definition with a non-operational definition		I	DE
11.3	Construct operational definitions		I	DE
<u>12.0 Designing an Experiment</u>				
12.1	Recognize the manipulated and responding variables			ID
12.2	Design, conduct and report an experiment using appropriate techniques			DE
<u>13.0 Formulating Models</u>				
13.1	Identify similarities and differences in the models of two systems		ID	D
13.2	Generate spatial models		ID	E
13.3	Generate mathematical models			ID

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APPENDIX "C"

SCIENCE PROCESSES DEVELOPMENT - PROBLEM SOLVING: K-9

PROBLEM SOLVING	K-3	4-6	7-9
1.0 Apply appropriate questions when a problem is stated _____	I	ID	E
2.0 Transform information into a representation illustrating a solution _____		I	DE
3.0 Recognizing alternative factors affecting possible solutions and propose strategies for solution _____		I	D
4.0 Establish criteria for judging a solution _____		ID	E
5.0 Collect, analyze and synthesize relevant information _____		ID	DE
6.0 Identify alternate models or drawings to illustrate a solution to a problem _____		I	D
7.0 Recognize, and define a problem in a researchable format _____			ID

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APPENDIX "D"

OBJECTIVES AND CONCEPTS FOR SCIENCE-TECHNOLOGY AND SOCIETAL INTERACTIONS

CONCEPTS

PROGRAM OBJECTIVES

SCIENCE AND TECHNOLOGY

- Science is the process of increasing and testing our knowledge of the natural world; enables us to predict the outcome of events in the natural world.
- Technology is the process of using resources and scientific knowledge to develop products and/or processes which attempt to resolve problems and/or needs of society.
- Science and technology advance one another. Technological processes are sometimes invented without knowledge of the scientific principle behind them.

The student will be able to:

- Distinguish between science and technology.
- Identify the principle(s) upon which simple technologies are based.
- Identify examples of interdependence between science and technology.

NATURE OF TECHNOLOGY

- Some technological devices and processes can be viewed as systems, or a series of simpler devices working as a system.
- Technological processes and devices extend the abilities of humans and affect the environment.
- A technological process or device often builds on past ones, becomes obsolete or can be changed and improved. Improvement may decrease the cost of the process.

- Identify the components of a functioning technological system including input, output, feedback and control.
- Describe ways technological processes are related and extends the abilities of humans.
- Explain why some processes become obsolete.

CONCEPTS

OBJECTIVES

INTERACTION OF SCIENCE, TECHNOLOGY AND SOCIETY

- Changes in either science-technology or society has often affected the other.
- Refinements in processes has resulted in new products to change lifestyles and industry.
- New industries may be created and others become obsolete, affect career choices, employment and education needs.
- A technological process or device is usually developed in response to needs; however, sometimes the device is developed and the need created by marketing.
- Technological advances have had global impacts.

MAKING DECISIONS

- Technological processes and devices offer increased choices. The purpose of a process and the choice made for its use determines its impact on society.
- Decisions should be based on long and short-term consequences. Resolution of complex issues requires data from experts in many disciplines. Experts often disagree about solutions.
- Trade offs are sometimes made between the advantages and disadvantages for people and the environment. Some burdens are accepted because benefits outweigh them.

- Demonstrate how science, technology and society are interrelated, it has improved the standard of living, imparted jobs and careers.
- Describe that science and technology alone cannot solve society's problem.
- Demonstrate that a technological process or device may be developed due to individual or societal needs and may be accepted or rejected because of societal attitudes.
- Identify how technological advances have affected the interactions of nations.
- Describe probable long and short-term consequences of a technological process or device.
- To assess and accept or reject a particular technological process or device based on its advantages and disadvantages.
- Demonstrate some alternative solutions to technological issues.

CONCEPTS

- A decision about a technological process or device leads to other questions and issues. Resolution of an issue may not be acceptable to all persons and groups.

- Governments sometimes pass laws to regulate and control use of a technological process e.g. seat belts, nuclear power. Growth of science and technology is affected by public funding decisions.

OBJECTIVES

Cite examples of legislation which has been passed to regulate a technological device.

OBJECTIVES	K-3	4-6	7-9
Students will be able to:			
<u>SCIENCE AND TECHNOLOGY DEFINED</u>			
Distinguish between science and technology	I		D
Identify scientific principles upon which a simple technology is based	I		D
Identify examples of interdependence of science and technology			ID
Identify components of a functioning technological system with inputs, outputs, feedback, control	I		D
<u>NATURE OF TECHNOLOGY</u>			
Describe how technological processes or devices are related to one another	I		D
Explain how technology extends the abilities of human beings and affect the environment	I	D	D
Explain how and why a technological process or device becomes obsolete or is modified		I	D
Demonstrate how science, technology and science interrelate, has affected living standards and imparted on jobs or careers			ID
<u>INTERACTION WITH SOCIETY</u>			
Recognize that science and technology alone cannot solve society's problems			ID
Demonstrate that processes and devices are sometimes developed in response to needs	I	D	D
Demonstrate that certain processes or devices are not accepted because of societal attitudes			
Identify advances in technological processes and devices that result in nations interacting as communities such as acid rain, satellite television			ID
<u>DECISIONS</u>			
Describe probable long and short term consequences of a technological process or device - increased choices, advantages and disadvantages			ID
Assess a process or device based on short and long-term consequences			ID
Demonstrate that several solutions may exist to technological issues			ID
Cite examples in which legislation has been passed to regulate a process or device			

CODE: I - Introduced to a limited degree
 D - Developed into new areas or in more complex forms.
 E - Extend process (student controlled and directed).

APPENDIX "E"

USES OF COMPUTERS IN SCIENCE

1. Tools
2. Experimentation
3. Simulation
4. Computer Assisted Learning (CAL)

Definitions

Tools - software which assists teachers or students to manipulate or manage information. Examples include word processors, databases, spreadsheets, graphics-generation software, and teacher utilities.

Experimentation - computer hardware and/or software used for the collection and preparation of data for analysis. Using hardware input devices, measurements such as temperature, light intensity, PH, electric current, and time could be gathered directly by the computer.

Simulation - courseware which imitates a system (ecology, astronomy), a process, training (balances, oscilloscope, titration), or an experiment (for reasons of cost, hazard, duration, etc.), or courseware which provides abstract simulations from, say, chemistry or physics.

Computer Assisted Learning (CAL) - courseware whose main purpose is either to teach concepts or skills (tutorials) or for drill and practice.

Problem solving and the problem-solving process are acknowledged as an integral part of K-9 science and as such they are not identified separately in this discussion.

Computers are not a substitute for a well-balanced science program. However, computer courseware can enrich the science curriculum and if the courseware has been well developed it can help to make science instruction more effective. Teachers are encouraged to evaluate available courseware to determine its effectiveness prior to making a purchase.

APPENDIX "G"

SAFETY IN SCIENCE

The science program has been designed to stimulate interest in the students by performing many hands-on activities. Positive attitudes towards safety and the proper use of laboratory equipment must be developed in the students. The major causes of accidents are negative attitudes towards safety and carelessness.

Although the majority of the topics and activities are relatively safe, the onus is on the administration and the teacher to ensure safe laboratory experiences. A safe laboratory must have safety equipment and safety instruction as to the use of the equipment.

A complete list and description of safety equipment and safety procedures may be found in Safety in Science, Curriculum Support Series. The manual is available through Manitoba Education.

WOMEN IN SCIENCE

The role of the female in science has not kept pace with the expanding effect of science and technology on society. A concerted effort is needed by all educators to change the attitude of early adolescent females towards science and their roles in the scientific community. Educators must make a conscious effort to eliminate the unconscious bias that exists in classrooms towards women in science.

Guidelines for Addressing Sexual Bias in Classrooms

Teachers can:

- . use inclusive, rather than exclusive, language.
- . assure that textbooks, reference materials, films, videos, visual displays give equal consideration to both sexes in career and lifestyle portrayals.
- . be aware that habit and tradition may result in different teacher expectations for girls than for boys and that the students own expectations may be reflected in their success rates. Both expectations may be communicated subtly and may, therefore, be difficult to detect and correct.
- . be aware that studies have shown that boys receive considerably more teacher feedback, occupy more physical space, are more critical of girls and of each other, and generally assume the leadership role in a mixed group. This has implications for almost every aspect of classroom management and methodology.
- . question not just the content of a curriculum, which often ignores or gives little attention to women's contributions, but the context and definition of success or knowledge, which often predetermines that what is seen as male and what is seen as a contribution are synonymous.
- . encourage projects which recognize skills and interests of both sexes and discourage put-downers or devaluing of "female" interests--by male students.

APPENDIX "H"

SCIENCE FAIRS

A science fair is an exhibition of innovative activities, hands-on experiments and/or scientific research or literature reviews. The most important feature of the science fair is the work of each individual student. The fair is a method or mechanism to display the creative work of the student.

Some of the benefits of carrying out a science fair project include:

- . the chance to express creativity and initiative in independent research;
- . the experience of the excitement and frustration of scientific research;
- . the opportunity to develop special skills in written communication, oral presentation and organization of work.

The work on a science fair project may be divided into three stages.

1. Preliminary planning and choosing of a topic.
2. Research or experimentation. Keep a daily log book.
3. Science fair project--the blackboard and display.

There are excellent publications, Science Fair Project Ideas, The Science Fair Rookie Kit and Handbook of Helpful Hints for Elementary Science Fairs, which are available to interested teachers. Refer to the annotations.

ANNOTATIONS

1. Science Fair Project Ideas--Youth Science Foundation, Suite 805, 151 Slater Street, Ottawa K1P 5H3.
2. The Science Fair Rookie Kit. MSSS. (Available through Manitoba Education and Training.)
3. Handbook of Helpful Hints for Elementary Science--T. Bilyk. (Available through Manitoba Education and Training.)

APPENDIX "I"

BASIC EQUIPMENT LIST

Grades 5 and 6

bar magnet
steel balls
paper clips
metre sticks
washers (different sizes)
spring balance (optional)
plastic pails
balloons
thread
string
paraffin wax
zinc sheets
copper
vinegar
lemon juice
compass
copper wire
steel wire
dry cell
6 volt batteries

sugar
sand
hand lens
microscope
modelling clay
candles
food colouring
bromthymal blue
alka seltzer tablets
yeast
rock samples
plaster of Paris
containers
birdseed
seeds (bean, chickpea)
pulleys
wheel and axle
screw nails
Lego or Mechano set (optional)
flashlight
globe
milk cartons
thermometer
barometer

APPENDIX "J"

Grades 7, 8 and 9

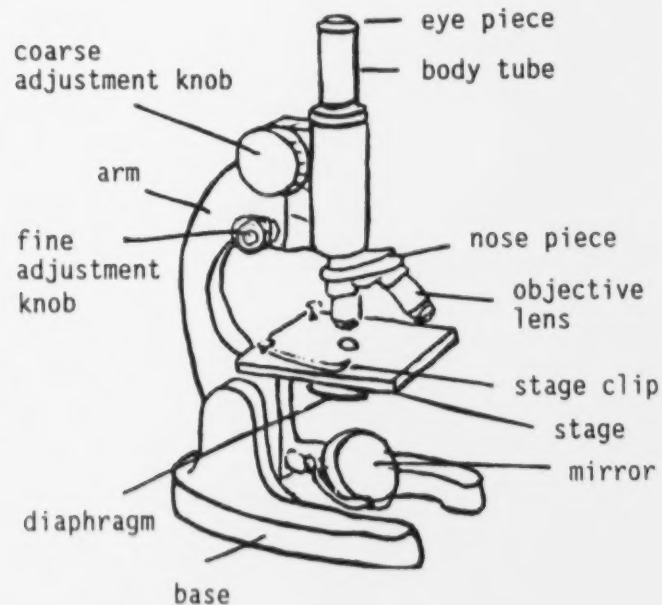
microscope
microscope slides, cover slips
hand lenses
yeast
thermometers
sugar
yo-yo
pendulum
light bulb
aquariums
flashlight
lens
glass prism
beakers
test tubes
variable size containers
protractor
drinking straws
tape
rubbing alcohol
food colouring
iron filings
mineral set
alum

spring scales
prepared slides of animal and plant cells
slides of blood cells
stop watch
paper clips
newsprint
fan
maps of Canada
map showing Continental Shelf
sand
soil
burners
ring stand
ring
clamps
bimetallic strip
bromothymal blue
litmus paper
pHydrion paper
household soaps, cleansers
shampoo
modelling clay
pulleys
protractor
spring scales
balance scale
gram weight set

APPENDIX "K"

THE MICROSCOPE

The microscope is an essential instrument in the study of living organisms because it enables the student to see things that are too small to be seen with the naked eye. The microscope the student uses in the science class is called a compound microscope because it has more than one lens. The part the student looks through is called the eyepiece and usually has a magnification power of 10X. This means that the object being viewed is enlarged ten times. The lenses attached to the nosepiece are called objective lenses. The number stamped on each lens indicates its magnification. For instance, if the eyepiece magnification is 10X, the total magnification of the microscope is $(10X) \times (10X)$ or 100 times.



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These procedures should be followed when using the microscope:

1. Carry the microscope with both hands, one hand under the base, and the other on the arm.
2. Stand facing a light source and set the microscope on the table with the arm toward you.
3. Turn the objective lens with the smallest magnification until it clicks into place under the body tube.
4. While looking through the eyepiece, adjust the diaphragm and the mirror so that the greatest amount of light is coming through the opening in the stage.
5. Place the prepared slide on the stage. Centre the specimen over the opening in the stage and use the stage clips to hold the slide in place.
6. Always look at the microscope from the side as you are using the coarse adjustment knob to lower the body tube until it almost reaches the slide. This will prevent you from breaking the slide and/or damaging the lens.
7. Look through the eyepiece, observe the specimen and slowly raise the body tube until the specimen comes into focus.
8. Always view the specimen with both eyes open. This will prevent eyestrain and allows you to make sketches of your observation without losing sight of the specimen.

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9. Make certain that the body tube is raised, before swinging the high-powered objective into place, so that the lens does not hit the slide.
10. Keep the microscope clean of dust, dirt and spilled fluids. Use lens paper for cleaning the lenses to avoid scratching them.

To prepare a wet mount place the specimen in the middle of a clean microscope slide. (The specimen must be thin enough to allow light to pass through it).

Place a drop of water on the specimen (use a medicine dropper).

Place one side of a clean cover slip at the edge of the drop of water. Slowly lower the cover slip over the specimen and water. (This will prevent air bubbles from forming over the specimen).

RESPONSE QUESTIONNAIRE FOR K-9 SCIENCE PROGRAM OF STUDIES

Please return this questionnaire by January 15, 1992 to the:

Science Consultant
Curriculum Services
Manitoba Education and Training
411-1181 Portage Avenue
Winnipeg, Manitoba R3G 0T3

Please respond to each question in the space provided. (Attach extra sheets if more space is required). Use the page references when making specific comments.

1. Does the guide provide you with sufficient information as to nature and scope of the science program?

2. Are you able to adequately cover the stated objectives within the available class time?

3. Are your students capable of achieving the objectives listed in the unit(s)?

4. Is there sufficient variety in the activities to allow all students to take part in the program?

5. Which activities are too simple or too difficult for the intended grade level?

6. Which activities do not seem to work well?

...../2

7. Which activities require clearer directions?

8. Are there sufficient material resources in your school to enable you to adequately teach the program?

9. Is there difficulty in obtaining science materials in order to carry out the activities?

10. Do the students enjoy or appreciate the program?

11. What are some specific features of the program with which you are pleased?

12. Within the framework of the revised program, please make suggestions which, in your opinion, may result in significant improvements.

NAME: _____ SCHOOL: _____

GRADE: _____ PHONE: _____

THANK YOU FOR YOUR ASSISTANCE.